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SCIENCE

11 November 1955

Volume 122, Number 3176

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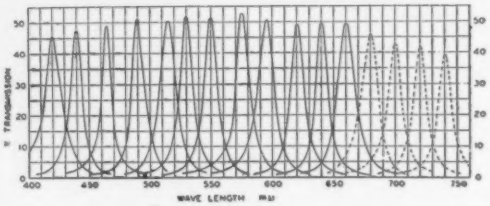

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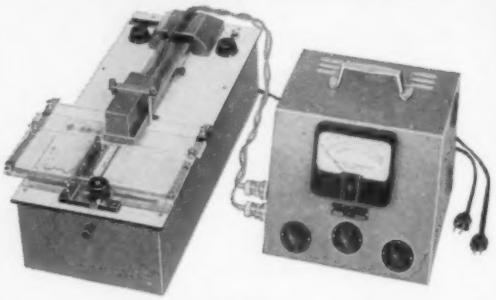

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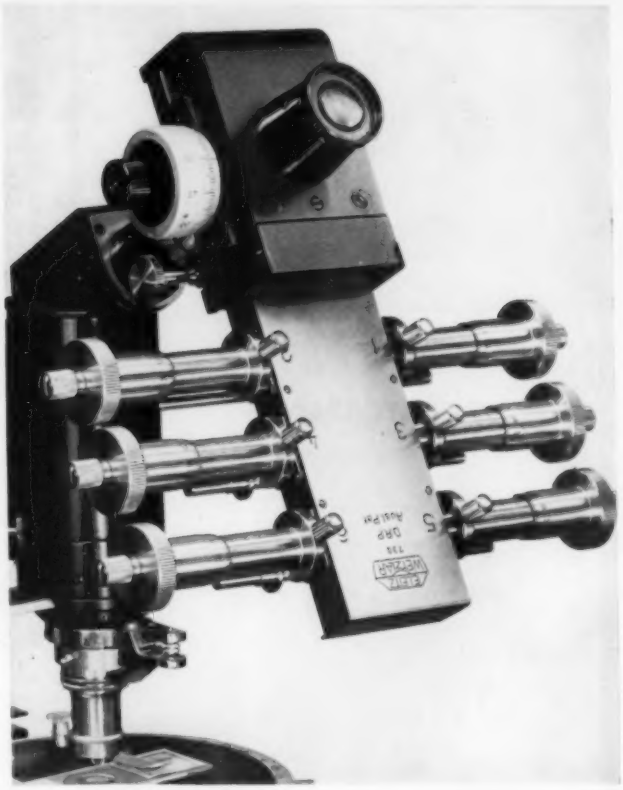

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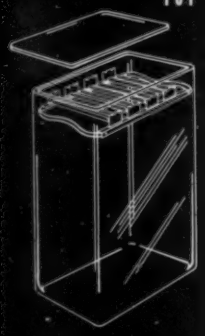

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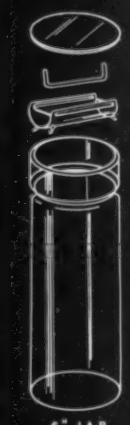

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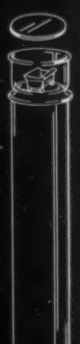

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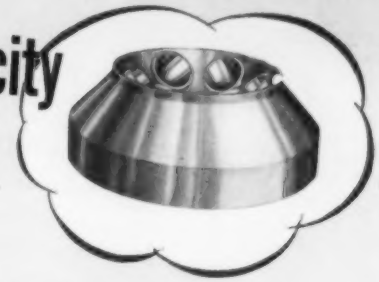

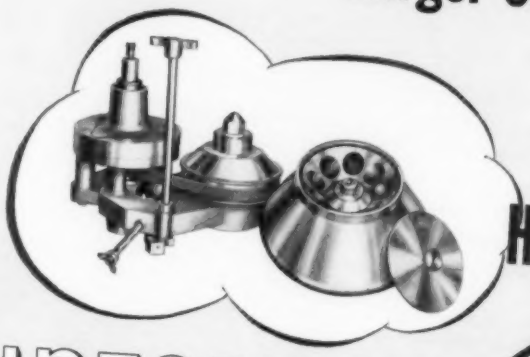

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Visitors' Visas

In May the Federation of American Scientists reported on the difficulty some foreign scholars have had in securing visas to visit the United States. The report presented a number of case histories, discussed the difficulties of holding international meetings in the United States, and presented a good case for H. R. 3998 or H. R. 4369, two Congressional proposals to eliminate some of the hindrances now experienced by foreigners who are invited to come to the United States to teach, lecture, or attend scientific, industrial, or cultural meetings.

The report reminded us of two earlier articles in *Science*. In his address as retiring president of the AAAS [**121**, 221 (1955)], E. U. Condon named some of the distinguished contributors to quantum physics: Planck and Einstein in Germany, Bohr in Denmark, Rutherford in England, Lewis in Berkeley, Compton in St. Louis, de Broglie in Paris, Davisson and Germer in New York, Thompson in England, Stern and Heisenberg in Germany, Eckhart in Pasadena, and so on through a continuing list that dramatically illustrated the international character of scientific progress.

The other article, by Edward Teller [**121**, 267 (1955)], traced the development of the hydrogen bomb. The men on Teller's list worked in the United States, but many came from other lands: Gamow from Russia, Bethe from Germany, Fermi from Italy, Oppenheimer from the United States, von Neumann from Hungary; and Konopinski, Bradbury, Nordheim, de Hoffmann, and others whose names indicate diverse family origins.

The United States has profited greatly from having such men, but in recent years has not been very hospitable either to permanent immigrants or temporary visitors. The FAS report describes the experiences of scientists who were invited to attend scientific congresses or to hold temporary teaching posts but who either were denied admission or who received visas too late to allow them to fulfill the purposes of their proposed visits.

But the picture may be changing. Last April the AAAS held an international meeting on arid lands research and utilization. Participants were selected wholly in terms of their scientific competence. Arrangements were made in advance and the State Department cooperated efficiently. Of the 31 invitees from other countries, only three declined, in each case for reasons unconnected with visa questions. The other 28 all came. One or two experienced slight delays, but not one reported any real difficulties. There have been other reports that entrance difficulties are lessening, and perhaps the current atmosphere of international cooperation may make it easier to bring foreign scholars to the United States.

If this expectation is justified it will mean that existing immigration law is not only out of step with what many consider good policy, but also out of step with current practice. For the law expresses none of the "welcome, friend" attitude currently evident in many international transactions. A change is in national as well as international interest, for an international conference is usually of greater benefit to the host country than to any other and a visit from a distinguished foreign scientist can be as worthwhile for the host as for the guest.—D.W.

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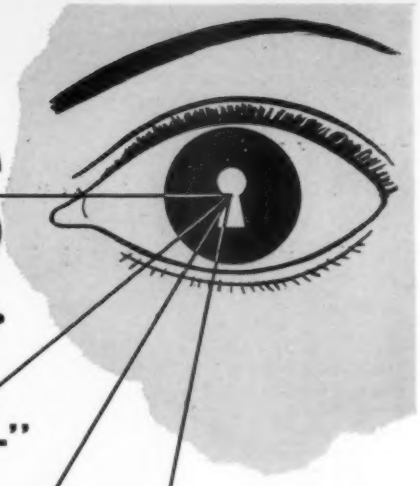

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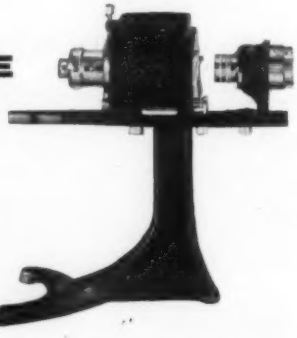

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Enzymatic Synthesis of Nucleic Acidlike Polynucleotides

Marianne Grunberg-Manago, Priscilla J. Ortiz, Severo Ochoa

The mechanisms of synthesis of the polynucleotide chains of nucleic acids have remained obscure despite notable advances in our understanding of the enzymatic mechanisms involved in the synthesis of the mononucleotides, the purine and pyrimidine bases, and the sugar moieties.

As briefly reported in a recent note from this laboratory (*1*), an enzyme isolated from the microorganism *Azotobacter vinelandii* catalyzes the synthesis of polynucleotides from 5′-nucleoside diphosphates with release of orthophosphate. The reaction requires magnesium ions and is reversible. The available evidence indicates that the *Azotobacter* enzyme catalyzes the reaction

$$n\ \text{X—R—P—P} \rightleftharpoons (\text{X—R—P})_n + n\ \text{P} \quad (1)$$

where R stands for ribose, P—P for pyrophosphate, P for orthophosphate, and X for one or more of the following bases: adenine, hypoxanthine, guanine, uracil, or cytosine.

Chemical and enzymatic degradation of the biosynthetic polynucleotides showed that they are made up of 5′-mononucleotide units linked to one another through 3′-phosphoribose ester bonds as in RNA (*2*). Thus, in analogy with polysaccharides, reversible phosphorolysis may be a major mechanism in the biological breakdown and synthesis of polynucleotide chains. For this reason, the name polynucleotide phosphorylase has been proposed (*1*) for the new enzyme. Evidence that this enzyme brings about the synthesis of RNA-like polynucleotides is presented in this article (*3*).

Dr. Ochoa is chairman and Miss Ortiz is research assistant of the department of biochemistry, New York University College of Medicine. Dr. Grunberg-Manago held a fellowship in the department while she was on leave of absence from the Institut de Biologie Physico-Chimique, Paris.

Polynucleotide Phosphorylase

The enzyme was discovered in the course of a study of biological phosphorylation mechanisms (*4*) when it was found that, in the presence of Mg^{++}, *Azotobacter* extracts catalyzed an exchange of P^{32}-labeled orthophosphate with the terminal phosphate groups of the 5′-nucleoside diphosphates of adenosine, inosine, guanosine, uridine, and cytidine. Following partial purification of the activity, there was no reaction with 5′-nucleoside mono- or triphosphates such as AMP, ATP, IMP, or ITP (*2*). The "exchange" was accompanied by the liberation of orthophosphate, as one would expect from the reaction of Eq. 1. With mixtures of 5′-nucleoside diphosphates, radioactive phosphate was incorporated in all of them.

As previously reported (*1*), the enzyme activity was purified about 40-fold through ammonium sulfate fractionation and calcium phosphate gel adsorption steps; the rate of the ADP-orthophosphate exchange was employed as an assay. The ratio of the rates of the ADP-orthophosphate exchange to orthophosphate liberation remained constant on purification, suggesting that the two activities were related to each other.

Single Polymers

On incubation of purified polynucleotide phosphorylase with nucleoside diphosphates in the presence of Mg^{++}, there is a disappearance of nucleoside diphosphate with liberation of a stoichiometric amount of orthophosphate. The reaction reaches equilibrium and comes to a standstill when about 50 to 60 percent of the nucleoside diphosphate has disappeared. The disappearing diphosphate is converted into a polynucleotide, as is borne out by the following facts. (i) The newly formed compound is strongly negatively charged, for it is retained by Dowex-1 anion exchange columns (*5*) following elution with formic acid at concentrations higher than those required to elute the most acidic mononucleotides. (ii) The product is nondialyzable against distilled water or dilute salt solutions and is quantitatively precipitated by trichloroacetic acid or alcohol in the cold. It can be isolated in this way. (iii) It is soluble in water, yielding more or less viscous solutions with a typical nucleotide ultraviolet absorption spectrum. (iv) It remains at the origin of paper chromatograms, whichever the solvent system used, and cannot be eluted with water.

Single polymers containing AMP, IMP, GMP, UMP, or CMP as the only basic unit have been obtained by incubating polynucleotide phosphorylase with the corresponding 5′-nucleoside diphosphates (*6*). If the use of heat and/or acid is avoided in the isolation of the polymers, their average molecular weight may be very high. Values of 570,000 and 800,000, respectively, were obtained by light scattering for the AMP and IMP polymers (*7*).

Mild alkaline hydrolysis (*8*) of the IMP polymer—that is, the polynucleotide formed from IDP—yielded an approximately equimolecular mixture of 2′-IMP and 3′-IMP. These products were identified by paper chromatography with the solvent system No. 3 of Markham and Smith (*9*). As is well known, RNA yields mixtures of the 2′- and 3′-mononucleotides on mild hydrolysis with alkali (*10*). The chromatographic identification of the alkaline hydrolysis products of the IMP polymer as 2′- and 3′-IMP has been confirmed by the following experiments (Table 1). (i) About 90 per cent of the product of alkaline hydrolysis of the IMP polynucleotide is hydrolyzed by 1.0*N* hydrochloric acid in 20 minutes. It will be observed that, under these conditions, both 2′-IMP and 3′-IMP are hydrolyzed to a similar extent—that is,

90 percent each—while 5′-IMP is hardly attacked. (ii) The alkaline hydrolysis product is not attacked by the specific 5′-nucleotidase of snake venom (*11*), which hydrolyzes 5′-IMP to the extent of 96 percent. (iii) The 3′- specific plant nucleotidase of Schuster and Kaplan (*12*)—which, as shown in Table 1, hydrolyzes 3′-IMP but not the 2′- or 5′-derivatives—hydrolyzes about half of the material. Inosine and 2′-IMP have been identified chromatographically as the products of incubation with this enzyme.

Further light on the structure of the biosynthetic polynucleotides has been shed by a study of their degradation by specific phosphodiesterases. These experiments have been partly carried out in collaboration with Leon A. Heppel of the National Institutes of Health. As shown in Fig. 1, snake venom phosphodiesterase (*13*) hydrolyzes RNA to yield 5′-mononucleotides, whereas the spleen phosphodiesterase of Heppel and Hillmoe (*14*) yields the corresponding 3′-mononucleotides (*10*). The action of each of these enzymes on various biosynthetic polymers, such as the AMP, the IMP, and some of the mixed polymers to be described in the next section, yields the expected 5′- or 3′-mononucleotides. These products were identified by chromatography and by the action of the specific mononucleotidases previously mentioned. Exhaustive digestion of the UMP polymer with crystalline pancreatic ribonuclease, a phosphodiesterase that mainly hydrolyzes the pyrimidine nucleotides of RNA as the 3′-derivatives, yields 3′-UMP while, with dilute enzyme, cyclic uridylic acid (2′-3′-uridine monophosphate) also accumulates to some extent (*15*). This is in agreement with observations on the action of pancreatic ribonuclease on RNA (*16*).

X-ray diffraction patterns of fibers (*17*) obtained from the AMP and other biosynthetic polymers closely resemble those produced by native RNA fibers (*18*).

Table 1. Products of alkaline hydrolysis of IMP polynucleotide. Polynucleotide was precipitated twice with trichloroacetic acid and hydrolyzed for 39 hours at 37°C in 0.4*N* KOH. Mixture was then treated with trichloroacetic acid; negligible precipitate was removed by centrifugation and discarded. The neutralized supernatant fluid contained 14.3 μmoles of mononucleotide based on ultraviolet absorption (λ, 260 mμ).

Treatment	Percentage of total P liberated				
	3′-IMP	2′-IMP	5′-IMP	Alkaline hydrolysate	
				Sample 1	Sample 2
1.0*N* HCl, 20 min, 100°C	90	90	6.5	89	93
5′-Nucleotidase			96	0.01	0.1
3′-Nucleotidase	80	1.6	0	54	53

Mixed Polymers

Mixed polymers—that is, polynucleotides containing two or more different basic units—have been prepared by incubation of mixtures of 5′-nucleoside diphosphates with polynucleotide phosphorylase. To date, two such polymers have been prepared, one from equimolecular mixtures of ADP and UDP (A-U polymer) and one from mixtures of ADP, GDP, UDP, and CDP in molecular proportion 1:0.5:1:1, respectively (A-G-U-C polymer). Degradation of the A-U polymer with purified snake venom phosphodiesterase yields 5′-AMP and 5′-UMP in a molar ratio of approximately 1:1. On digestion with pancreatic ribonuclease, it yields (*15*) 3′-UMP, as well as di-, tri-, tetra-, and pentanucleotides containing one uridylic acid unit and one or more adenylic acid units, along with a "core" consisting of adenylic acid residues.

The mixed polymers are more readily attacked by ribonuclease than mixtures of the corresponding single polymers (*19*). This is shown in Table 2 for the A-U polymer and the corresponding mixture. The same point is illustrated in Table 3 for the A-G-U-C polymer and the control mixture of single polymers. The AMP polymer, as expected, is not attacked by ribonuclease. Paper chromatography of the ribonuclease digestion mixtures with the solvent system of Krebs and Hems (*21*) confirmed these results. It appears as if the purine nucleotide polymers interfere with the action of ribonuclease on the pyrimidine nucleotide polymers in the mixtures. It may further be seen (Table 3) that the reactivity of the A-G-U-C polymer toward ribonuclease was similar to that of yeast RNA. This similarity was further stressed by the fact that upon exhaustive ribonuclease digestion of (i) yeast RNA and (ii) the A-G-U-C polymer, 20 and 22 percent, respectively, remained as a "core" (*22*) that was nondialyzable against distilled water, while after the same treatment of the mixture of AMP, GMP, UMP, and CMP polymers used in experiment 4 of Table 3, 43 percent remained as a nondialyzable "core."

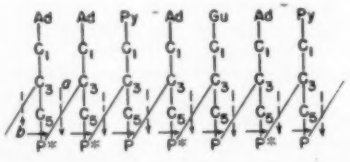

Fig. 1. Cleavage of polynucleotides by snake venom (vertical dashed arrows *a*) and spleen (horizontal arrows *b*) phosphodiesterase. *Ad*, adenine; *Gu*, guanine; *Py*, pyrimidine bases. The P^{32} label is indicated by the asterisk.

Hydrolysis of the A-G-U-C polymer with perchloric acid liberates the four bases, adenine, guanine, uracil, and cytosine. Figure 2 shows the ultraviolet photograph of an isopropanol-HCl paper chromatogram of the hydrolysate (*23*).

Further proof that 5′-3′-phosphoribose diester bonds between different mononucleotide units occur in mixed polymers was obtained from experiments in which such polymers were synthesized from mixtures of ADP labeled with P^{32} in two phosphate groups (*24*) with other nonlabeled 5′-nucleoside diphosphates (*25*). Through the action of polynucleotide phosphorylase, the labeled nucleotide is incorporated in a polynucleotide chain as adenosine-5′-(P^{32}) phosphate (Fig. 1) with release of P^{32}-orthophosphate. As may be seen on inspection of Fig. 1, if links are established between the labeled AMP and the other nucleotides, the latter will be released as *labeled* 3′-mononucleotides on hydrolysis of the polymer with spleen phosphodiesterase, while the specific radioactivity of the 3′-AMP thus obtained will be lower than that of the 5′-AMP incorporated. On the other hand, 5′-AMP of the same specific radioactivity as that incorporated will be the only labeled nucleotide released by hydrolysis with snake venom phosphodiesterase, the other 5′-nucleotides being unlabeled. Such results were indeed obtained in experiments in which the nucleotides liberated by phosphodiesterase digestion were identified by paper chromatography and autoradiography. These experiments, a detailed report of which is in preparation, were carried out with biosynthetic polymers prepared from (i) labeled ADP alone, (ii) UDP alone, (iii) labeled ADP together with UDP, and (iv) labeled ADP together with GDP, UDP, and CDP. Control mixtures of single labeled AMP polymer with either (i) nonlabeled UMP polymer or (ii) nonlabeled GMP, UMP, and CMP polymers, yielded only labeled AMP (either 3′- or 5′), the other mononucleotides being unlabeled in all cases.

Reversibility

As already indicated, the reaction catalyzed by polynucleotide phosphorylase is reversible. In the presence of the enzyme, orthophosphate, and Mg^{++}, the biosynthetic polynucleotides undergo phosphorolysis to yield the corresponding 5′-nucleoside diphosphates. There is no reaction in the absence of orthophosphate. Quantitative data on the stoichiometry of the reaction with IDP in both directions have been presented previously (*1*). We have as yet no accurate data on the position of the equilibrium. In the direction of polynucleotide synthesis and under our usual experimental conditions (*p*H 8.1, 30°C), the reaction comes to a standstill when the ratio of the concentration of orthophosphate to that of nucleoside diphosphate is from 1.5 to 2.0. The reaction favors to some extent polynucleotide synthesis, as would be expected from the fact that the pyrophosphate bonds of nucleoside diphosphates are converted to the phosphodiester bonds of the polynucleotide.

For reasons at present not well understood, single polymers are phosphorolyzed more readily than mixed ones. As already reported (*1*) phosphorolysis of RNA isolated from *Azotobacter* has been shown through the incorporation of radioactive phosphate and chromatographic identification of radioactive ADP, GDP, UDP, and CDP. The identity of the labeled GDP and UDP thus formed was further established through specific enzymatic hydrolysis with inosine diphosphatase (*26*). It has also been found with the same technique that the *Azotobacter* enzyme can catalyze the phosphorolysis of ribonucleic acids from other sources (yeast, ox liver, *Escherichia coli*, and *Streptococcus pyogenes*); this indicates lack of specificity in this regard. However, samples of DNA from calf thymus, as well as a sample of ribonuclease-resistant "core" from yeast RNA, were not attacked (*27*).

Table 2. Brief ribonuclease digestion of biosynthetic polynucleotides. Details: 0.5 ml reaction mixture with 50 μmoles of Tris buffer, *p*H 7.35, 1.48 μg of crystalline pancreatic ribonuclease, and polymers as indicated: incubation 20 min at 30°C. Hydrolysis was determined by a modification of the method of Anfinsen *et al.* (*20*) through the disappearance of ultraviolet absorbing material (λ, 260 mμ) precipitable by uranium acetate-perchloric reagent.

Polymer	Micromoles*	Hydrolysis (%)
AMP	2.75	0
UMP	2.80	60
A-U	2.44	77
AMP + UMP†	2.26	15 (28)‡

* Expressed as mononucleotide.
† Single AMP (1.06 μmoles) and UMP (1.20 μmoles) polymers mixed and kept overnight at 30°C prior to ribonuclease digestion.
‡ Value in parentheses gives the percentage of UMP polymer hydrolyzed assuming that only this component of the mixture is attacked by ribonuclease.

Conclusion

Present information on structure, size, x-ray diffraction pattern, and behavior toward different enzymes indicates that the polynucleotides synthesized by polynucleotide phosphorylase from 5′-nucleoside diphosphates are closely related to RNA. Indeed the A-G-U-C polymer—that is, the one containing adenylic, guanylic, uridylic, and cytidylic acid residues—appears to be indistinguishable from native RNA. However, it would be desirable to ascertain whether the biosynthetic compounds exhibit biological properties such as an effect on protein synthesis before referring to them as nucleic acids.

Whether or not the reaction catalyzed by polynucleotide phosphorylase represents a general biological mechanism for the synthesis of ribonucleic acids cannot as yet be decided, although such a possibility would not appear unlikely. The enzyme is present in microorganisms other than *Azotobacter* (*28*), but we have so far been unable to obtain unequivocal evidence for its presence in yeast and animal tissues.

Since there is evidence that ribonucleic acids from different cells or tissues vary in composition (*22*), the question whether polynucleotide phosphorylases from different sources would bring about the synthesis of polynucleotides characteristic of the various sources is of obvious interest. Not unrelated to this problem, because of the specific genetic effects of deoxyribonucleic acids (*29*), is the question whether DNA-like polynucleotides can be synthesized by a similar mechanism. It is to be hoped that answers to some of these pressing questions will soon be forthcoming.

Fig. 2. Perchloric acid hydrolysis of A-G-U-C polymer.

Table 3. Prolonged ribonuclease digestion of biosynthetic polynucleotides and yeast RNA: Details: 1.6 ml reaction mixture with 20 μmoles of Tris buffer, *p*H 7.0, 29.6 μg of ribonuclease, and polymers as indicated. Incubated at 37°C. Other details as in Table 2.

Expt. No.	Polymer	Micromoles*	Hydrolysis (%)		
			3 hr	4 hr	7 hr
1	AMP	19.3	0	0	0
2	Yeast RNA	13.9	77	84	84
3	A-G-U-C	17.9	88	90	90
4	Mixture†	14.0	19 (34)‡	32 (57)	37 (65)

* Expressed as mononucleotide.
† Mixture of single polymers as follows: AMP, 4 μmoles; GMP, 2 μmoles; UMP, 4 μmoles; CMP, 4 μmoles.
‡ Values in parentheses give the percentage hydrolysis of the pyrimidine nucleotide polymers in the mixture, which make up 57 percent of the total, assuming that only these components are attacked by ribonuclease.

References and Notes

1. M. Grunberg-Manago and S. Ochoa, *J. Am. Chem. Soc.* 77, 3165 (1955).
2. Abbreviations: ribonucleic acid, RNA; 5′-diphosphates (pyrophosphates) of adenosine, inosine, guanosine, uridine, and cytidine, ADP, IDP, GDP, UDP, and CDP; 5′-monophosphates of the same nucleosides, AMP, IMP, GMP, UMP, and CMP; corresponding 3′-monophosphates, 3′-AMP, and so forth; adenosine and inosine triphosphates, ATP and ITP; deoxyribonucleic acid, DNA; tris(hydroxymethyl)aminomethane, Tris.
3. This work was aided by grants from the National Institute of Arthritis and Metabolic Diseases (grant A-529) of the National Institutes of Health, U.S. Public Health Service; the American Cancer Society (recommended by the Committee on Growth, National Research Council); the Rockefeller Foundation, and by contract N6onr 279, T.O.6 between the Office of Naval Research and New York University College of Medicine. These results were presented at the third International Congress of Biochemistry, Brussels, Belgium, 3 Aug. 1955.

4. M. Grunberg-Manago and S. Ochoa, *Federation Proc.* **14**, 221 (1955).
5. Based on W. E. Cohn, *J. Am. Chem. Soc.* **72**, 1471 (1950).
6. We wish to thank M. Staehelin and M. C. Schneider for the preparation of some of the polynucleotide phosphorylase used in this work. We are deeply indebted to Dan Broida, Sigma Chemical Company, St. Louis, Mo., for generous gifts of UDP, GDP, IDP, and other nucleotides. The present work would not have been possible without this help. We are also indebted to Alexander Frieden and Samuel A. Morell, Pabst Laboratories, for gifts of CDP and UDP.
7. L. F. Cavallieri and M. Rosoff, unpublished experiments.
8. E. Vischer and E. Chargaff, *J. Biol. Chem.* **176**, 715 (1948); C. E. Carter, *J. Am. Chem. Soc.* **72**, 1466 (1950).
9. R. Markham and J. D. Smith, *Biochem. J.* **49**, 401 (1951).
10. See W. E. Cohn, D. G. Doherty, E. Volkin, in *A Symposium on Phosphorus Metabolism* (Johns Hopkins Press, Baltimore, 1952), vol. 2, p. 339.
11. J. M. Gulland and E. M. Jackson, *Biochem. J.* **32**, 590, 597 (1938); R. O. Hurst and G. C. Butler, *J. Biol. Chem.* **193**, 91 (1951).
12. L. Schuster and N. O. Kaplan, *J. Biol. Chem.* **201**, 535 (1953).
13. We are greatly indebted to C. E. Carter, Yale University, for a gift of highly purified snake venom phosphodiesterase free of monoesterase.
14. L. A. Heppel, R. Markham, R. J. Hillmoe, *Nature* **171**, 1152 (1953); L. A. Heppel and P. R. Whitfeld, *Biochem. J.* **60**, 1 (1955). We are greatly indebted to Heppel for generous gifts of this enzyme and other nucleases.
15. L. A. Heppel, unpublished experiments.
16. R. Markham and J. D. Smith, *Biochem. J.* **52**, 552, 558 (1952).
17. A. Rich and J. D. Watson, *Proc. Natl. Acad. Sci. U.S.* **40**, 759 (1954).
18. A. Rich, unpublished experiments.
19. Some differences in their electrophoretic behavior have also been indicated by experiments of R. C. Warner in our laboratory.
20. C. B. Anfinsen, *et al.*, *J. Biol. Chem.* **207**, 201 (1954).
21. H. A. Krebs and R. Hems, *Biochim. et Biophys. Acta* **12**, 172 (1953).
22. S. Zamenhof, in *A Symposium on Phosphorus Metabolism* (Johns Hopkins Press, Baltimore, 1952), vol. 2, p. 301.
23. This experiment was carried out by J. R. Fresco.
24. Prepared by the Schwarz Laboratories, Mount Vernon, N.Y.
25. These experiments were suggested by G. W. E. Plaut.
26. G. W. E. Plaut, *Federation Proc.* **14**, 263 (1955). We are indebted to Plaut for a generous gift of this enzyme. It catalyzes the hydrolysis of IDP, GDP, and UDP, but is inactive on ADP and CDP.
27. Our thanks are due to A. W. Bernheimer for the samples of bacterial and ox liver RNA, to J. R. Fresco for those of yeast RNA and calf thymus DNA, and to L. A. Heppel for the sample of yeast RNA "core."
28. In extracts of *Alcaligenes faecalis* (supplied by G. B. Pinchot, Yale University). Also, D. O. Brummond (unpublished experiments) has found the enzyme in extracts of *Clostridium kluyveri*.
29. R. D. Hotchkiss, *The Harvey Lectures* (Academic Press, New York, 1955), ser. 49, p. 124.

Egon Brunswik, Psychologist and Philosopher of Science

I first met Egon Brunswik in Vienna in the winter of 1933–34. He was chief assistant in Karl Bühler's Institute of Psychology at the University of Vienna. He became Privatdozent the following fall. In an exciting series of experiments, he and his students were then demonstrating that, in perceiving, the organism may be "achieving" either the "thing-characters"—size, shape, brightness, and so forth—(of objects) or the immediate "perspective characters," of these same objects or more often some compromise between thing characters and perspective characters. And he had just finished his theoretical and empirical discussion of these findings in the book *Wahrnehmung und Gegenstandswelt* (1934), with the subtitle "Psychologie vom Gegenstand her." As a result of our meeting Brunswik spent a year as a Rockefeller fellow in the department of psychology at the University of California at Berkeley in 1935–36 and in the fall of 1937 permanently joined the Berkeley department.

Brunswik has made four major contributions to psychology: (i) his work on perception as such; (ii) his applications of the history and philosophy of science to psychology; (iii) his demonstrations that not only perception but also thinking and valuing are fruitfully conceived as only in some degree probabilistically valid achievements; and (iv) his insistence on the need for truly "representative design" in the sampling of the environment—for, as he points out, the environment usually presents to the organism cues of only low "ecological validity."

Brunswik's untimely death on 7 July 1955, at the age of 52, came just as his doctrines of functionalistic achievement, representative design and ecological validity had begun to arouse widespread attention both in this country and abroad. It is fortunate that his last work, now in press, a revision and expansion of his monograph on representative design, will serve as an effective and definitive statement of these positions. His was an extraordinarily informed, rich, and subtle mind. And he was never willing to oversimplify or restrict the actual complexities of the relationships with which he was concerned. This always makes the reading of whatever he wrote a difficult task but an exciting and stimulating challenge.

Although, intellectually, somewhat rigorous and aloof, in his human relationships he was simple, friendly, and generous. Unfortunately, he had suffered for many years from very high blood pressure. And he had had to give up the long walks, the mountain climbing, and most of the social activities of his youth.

Born in Budapest of a Hungarian father and an Austrian mother, he was sent as a small boy to the famous Gymnasium of the Theresianische Akademie in Vienna to be prepared for a position as a government official in the old Austro-Hungarian Empire. This education was interrupted by World War I. After the war he was sent for some months to Sweden to overcome the effects of the malnutrition that resulted from the war years. Completing the gymnasium in 1921, he first studied for 2 years to be an engineer at the Technische Hochschule; he then changed to philosophy and psychology at the University of Vienna. Here he came not only under Karl Bühler and the latter's interest in cognitive processes but also under Moritz Schlick and the entire "Vienna Circle" who were then developing the tenets of logical positivism. In this country Brunswik became an active member of the movement toward the unity of science. In the summer of 1953 he organized and participated in the Berkeley Conference for the Unity of Science at the University of California. This, in which he performed brilliantly, took a heavy toll from his health.

Although his own empirical work was largely restricted to perception and learning, Brunswik was extremely sympathetic to the wider sociological and psychoanalytical studies of his wife, Else Frenkel-Brunswik. He was indeed hospitable to all systematic ideas, even when he was unable immediately to incorporate them into his own thinking. His was not only a generous personality but also a generous mind.

His friends, colleagues, and students, and our science as a whole, will miss profoundly his eager, insightful personality and the further vigorous, devoted development of his own original and important basic presuppositions concerning the problems and methodology of psychology.

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War and Men of Science

Ilse Bry and Janet Doe

The Russell-Einstein plea for the abolition of war (*1*) calls to mind earlier efforts of scientists to make science serve the welfare of mankind, one of which was an appeal signed by Einstein before World War I. In the spring of 1912 a group of scholars distinguished in philosophy and science invited all philosophically minded scientists to join a Gesellschaft für positivistische Philosophie, with the aim of arriving at a unified scientific, rigorously empirical conception of the world. Einstein, at the age of 33, was by far the youngest of the 33 signers, who included such deans and pioneers in their respective fields as Sigmund Freud, Ernst Mach, Felix Klein, David Hilbert, August Forel, Jacques Loeb, Josef Popper, Hugo Ribbert, Wilhelm Roux, and F. C. S. Schiller. The oldest, the philosopher Wilhelm Schuppe, was then 76 years old, as was Einstein when he signed his last appeal. By number as well as by eminence of their members, the following branches of science were about equally well represented: philosophy and psychology; physics and technology; medicine and psychiatry; biology and physiology; mathematics and astronomy; and sociology, including history and law (*2*).

Leading philosophical and scientific journals on the Continent and in this country carried the appeal (*3–7*), its accompanying statement (*8–9*), or a résumé with comments (*10–13*). Although it was "scientific news" of the years 1912–13, the document seems to have been buried ever since. The explanatory statement strikingly conveys to us today the spirit that then prevailed: first, the firm belief that a total mastery of scientific fact must be tantamount to the self-mastery of man; second, an awed feeling that the special sciences were approaching their own limits; and third—astounding for an era already apprehensive of a threatening war—an Olympian indifference to the nether realms of politics, power, and peace (*8*).

"There has long been felt the need of a philosophy which should grow in a natural manner out of the facts and problems of natural science. The mechanical view of nature no longer satisfies this need. Let any one recall the 'Ignorabimus' of Du Bois Reymond and the various attempts to relate mechanical and psychological processes by means of neovitalistic concepts, attempts of physicists as well as of biologists. The current philosophy, of Kantian origin for the most part, or with strongly Kantian emphasis, is impotent here, because it directs its inquiries without any deep appreciation of the need in question, because it treats of problems scarcely intelligible to anyone who comes to them from the natural science of to-day, and because it is usually not able to go far enough into the questions of natural science.

"To be sure, there has grown up from the soil of natural science itself a strictly empirical and positivistic point of view quite indifferent to metaphysical speculation and to so-called critical, transcendental doctrines. Its principles are however not yet accepted in their essential meanings and systematic relations throughout considerable scientific circles. They are even completely misunderstood by distinguished scientists as they are by most of the influential philosophers.

"On the other hand the particular sciences find themselves forced to consider problems of even greater generality so that they take on of themselves a philosophical character. Mathematics advances to higher and higher abstractions. Geometry, in its deductive development, is freeing itself from all intuition after overcoming the limits of the Euclidean conception of space. In the theory of groups it has reached a positive treatment of the concept of infinity, once a purely negative idea, and it faces now the question of its differentiation from logic. Physics has been made to include more and more remote fields of research. Optics and all the phenomena of radiation have been brought under the concepts of electromagnetic theory, and physics has now before it the question, how far can mechanics be interpreted in terms of electromagnetism? In the theory of relativity it touches the most searching question thus far of epistemology: Is absolute or is only relative knowledge attainable? Indeed: Is absolute knowledge conceivable? It comes here directly upon the question of man's place in the world, the question of the connection of thought with the brain. What is thought? What are concepts? What are laws? In psychological problems, physics and biology come together. And finally, the anthropological sciences, especially history and sociology, find themselves brought into closer and closer connection with biological concepts.

"Those who take an interest in these progressive inquiries will find it to their advantage to have a scientific association which shall declare itself opposed to all metaphysical undertakings, and have for its first principle the strictest and most comprehensive ascertainment of facts in all fields of research and in the development of organization and technique. All theories and requirements are to rest exclusively on this ground of facts and find here their ultimate criterion.

"Annual reports will bring together all branches of the association, the bibliographies will be collected of the material that can be made to contribute to strictly positivistic theory, and as soon as possible a periodical, for which the resources are already assured, will serve the undertaking.

"We ask for members and active cooperation. If all those who are competent and earnest in genuinely scientific philosophical work, or who take an interest in the progress and results of such research, will write in this way we cannot fail to meet with success, which will lead us in no distant future out of the unsatisfactory conditions of the present. The present day is surfeited with the fruitless and nearly uniform repetition of philosophical ideas, often expressed before, but not sufficiently clear and concrete, and, on the other hand, with the increasing separation of science into ever smaller divisions and with the merely external accumulation of results. The present day desires the solution of general problems, which research itself throws up, and is not to be put off with an *Ignorabimus* for which there is no evidence."

The Gesellschaft für positivistische Philosophie, with its headquarters in Berlin, was indeed founded and held its opening session in November 1912. By June 1913 the society had 170 members (*14*). From a French report, we gather that the membership list then included Bektherev (St. Petersburg) and Enriques (Bologna). An ominous note was sounded in the expressed regret that no French name appeared on the list, al-

Dr. Bry is in charge of the Neuropsychiatric Library of New York University–Bellevue Medical Center, New York. Miss Doe is librarian of the New York Academy of Medicine, New York, N.Y. This review of the interest of scientists in the prevention of war shows the late Albert Einstein's great leadership for nearly half a century in shaping our thinking about the implications and consequences of scientific developments and events as well as his leadership in scientific progress itself.

though science had received its classic form through the French scientists of the 17th and 18th centuries, and in the suggestion to form an analogous society in France under the name Amis de la Science (*13*).

The organ of the German society began in 1913 as *Zeitschrift für positivistische Philosophie* but ceased the next year with volume 2, numbers 3 and 4 (*14*). The last issue includes a paper by one of the founders of the society, Joseph Petzoldt, on the biological foundations of psychology (*15*); it had been prepared for the Fourth International Congress for Neurology, Psychiatry, and Psychology, which was to be held in Bern in September 1914 but convened instead in Paris in 1923.

Although the war put an end to this first collective effort, the same spirit was revived by a younger generation of scientists in the 1920's, particularly in the Vienna Circle around Moritz Schlick. In Berlin the prewar philosophical society was followed, in 1928, by the Gesellschaft für empirische—later "wissenschaftliche"—Philosophie, whose members were, among others, Hans Reichenbach, Kurt Lewin, and Wolfgang Köhler. Its object was to promote "a philosophical method which advances by analysis and criticism of the results of the special sciences to the stating of philosophical questions and their solutions." The journal sponsored by this group from 1930 on was significantly named *Erkenntnis,* since it was felt that the goal of cognition was set for philosophy in the same sense as for each special science (*16–18*).

Nicolai-Einstein-Förster Manifesto

With inconspicuous beginnings World War I had set in motion a new development destined to overtake the tradition "that it was undesirable that scientists should mix themselves up in the hurly-burly of the world" (*19*). The pacifist stand taken by Einstein over the years is amply recorded (*21–23*), and it is well known that, in October 1914, he did not sign the manifesto of the 93 German intellectuals protesting their fatherland's innocence of war guilt and identifying German militarism with German civilization. The countermanifesto, drafted later that same month by Georg Friedrich Nicolai, Albert Einstein, and Wilhelm Förster, has received less attention, although historical perspective has made it more important. Nicolai gives a full account of both documents in the "Introduction" to his *Biology of War* (*19*). He also records the excuse—"if it be an excuse"—that some of the signers had never read the notorious manifesto but had authorized their signatures on the strength of a telegram from the influential politician Erzberger. His words sound prophetic:

"The fact remains, however, that this manifesto was published and distributed broadcast; and considering how the war seemed to have metamorphosed men of science, it seemed desirable, not to say necessary, to appeal to a wider public especially to maintain a uniform conception of civilization, just then divided. For although only the few are capable of promoting civilization, yet it is by the standard of popular feeling that the maintenance of its continuity is insured."

The appeal of the three famous pacifist scientists stated in part:

"Technical science and intercommunication are clearly tending to force us to recognize the fact that international relations exist, and consequently that a world-embracing civilization exists. Yet never has any previous war caused so complete an interruption of that cooperation which should exist between civilized nations.

". . . Those who care in the slightest degree for this universal world civilization are under a twofold obligation to strive for the maintenance of these principles. Those who might have been expected to care for such things, in particular men of science and art, have hitherto almost invariably confined their utterances to a hint that the present suspension of direct relations coincided with the cessation of any desire for their continuance.

"Such feelings are not to be excused by any national passions. They are unworthy of what everyone has hitherto understood by civilization. . . . Hence it must be the duty of educated and philanthropic Europeans to make, at any rate, an effort lest Europe . . . should suffer the same tragic fate as ancient Greece. Is Europe gradually to be exhausted by fratricidal war and perish?

"The war raging at present will scarcely end in a victory for any one, but probably only in defeat. . . .

"It seems to us before all else necessary that there should be a union of all in any way attached to European civilization. . . . We must never abandon hope that their collective pronouncement may be heard by someone even amidst the clash of arms, most especially if the 'good Europeans' of to-morrow include all those who are esteemed and considered as authorities by their fellow-men.

"To begin with, however, it is needful that Europeans should unite. . . . We ourselves wish only to give the first impulse to such a union; wherefore we ask you, should you be in agreement with us, and, like us, bent upon making the determination of Europe as widely known as possible, to send us your signature."

To this manifesto, which was privately distributed, many sympathetic letters were received, yet most of the writers declined to sign it. Denied the necessary backing by well-known names, the plan was dropped (*19–21*).

Changing Attitude toward Scientific Progress

Almost two decades later the growing concern with the position of the scientist in the vital, nonscientific matter of war and peace found another dramatic expression in the Einstein-Freud correspondence *Why War?* (*23*), which resulted from a proposal of the League of Nations International Institute of Intellectual Cooperation that Einstein choose an important topic and an eminent scholar with whom to discuss it publicly. Einstein selected "the most insistent of all the problems civilisation has to face":

"Is there any way of delivering mankind from the menace of war? It is common knowledge that, with the advance of modern science, this issue has come to mean a matter of life and death for civilisation as we know it; nevertheless, for all the zeal displayed, every attempt at its solution has ended in a lamentable breakdown."

The exchange of letters took place in 1932, a year before science was once more affected by the political events in Germany.

Outside of Germany the movement toward unity of science, based on positivism and logical empiricism, gathered new strength. International Congresses for the Unity of Science were held, from 1935 on, in Paris, in Copenhagen, in Paris again, in Cambridge, England, and at Harvard. The sixth and last of the congresses convened at the University of Chicago in 1941. The *International Encyclopedia of Unified Science,* planned in 1935, began publication in 1938. Yet, as before, these endeavors of the scientists were disturbed and discontinued by the advent of war. The periodical *Erkenntnis,* in 1939 renamed *Journal of Unified Science* and published in The Hague, ceased in April 1940 (*17, 18, 24*).

After World War II we find the scientists rallying again to the banner of unification of scientific knowledge, concepts, and total outlook. A new German journal appeared in 1947, *Studium Generale,* devoted to the unity of the sciences in the context of their conceptualizations and research methods; only this time the synthesis of science was sought in explicit juxtaposition to philosophy (*25*). In this country work on the *International Encyclopedia of Unified Science* was resumed; in 1949 a grant from the Rockefeller Foundation made possible the incorporation of the *Institute for the Unity of Science,* which has since been in charge of the project (*18*).

However, there was one difference: scientific progress was no longer being unquestionably identified with the road to human perfection—this equation had become a casualty at Hiroshima. At about the time of the first appeal, in August 1912, *Science* printed a lecture by Victor C. Vaughan on "The philosophy of a scientist" which proclaimed (*26*):

"No philosophy evolved from the inner consciousness of man has ever done man half the good that has been secured to him by the discovery of the agents of infection. In fact no important discovery in science has failed to better the lot of man. . . .

"The scientist, even though he be a rank materialist without any belief in the supernatural . . . has his dreams of the future. He dreams of the time when the engines of destruction will be so powerful and certain in action that war will be impossible, and the world shall become one great community of enlightened, intelligent human beings, dwelling in peace and unity."

By the middle of the century, scientists believed that engines of destruction had become powerful enough and sufficiently certain in action to annihilate life on earth; but they were not so sure that this meant fulfillment of the rest of the dream. They were also aware of the profound change that had taken place in their own reaction. To illustrate this change, Richard von Mises quoted the closing words from Mach's *Erkenntnis und Irrtum* (1905) (*27*):

"If we consider the tortures which our ancestors had to suffer from the brutality of their social institutions, their conditions of law and justice, their superstitions, and their fanaticism, if we realize the abundant present inheritance of these goods, and if we imagine how much of this we shall still experience in our descendants, this is a sufficiently powerful incentive for us to cooperate vigorously and vehemently in the realization of the ideal of a moral world order by means of our psychological and sociological knowledge. But once we have created such a moral order, nobody will be able to say any longer that it is not of this world, and nobody will have to look for it any longer in mystical heights or depths."

Von Mises, himself a positivist, writing in 1951, had this comment: "Who can believe that these words would have been written if Mach had lived through the last few decades?"

Social Responsibility in Science

The new mood of the scientific world found its first positive expression in the formation of the Society for Social Responsibility in Science, with the aim (*28*):

" . . . to foster throughout the world a . . . tradition of personal moral responsibility for the consequences for humanity of professional activity, with emphasis on constructive alternatives to militarism; to embody in this tradition the principle that the individual must abstain from destructive work and devote himself to constructive work, according to his own moral judgment; to ascertain . . . the boundary between constructive and destructive work, to serve as a guide for individual and group decisions and action. . . ."

Once more it was Einstein who served as spokesman for the scientific *avant-garde*. *Science* published his letter written upon joining the society in the summer of 1950; the last paragraph states (*29*):

"In our times scientists and engineers carry particular moral responsibility, because the development of military means of mass destruction is within their sphere of activity. I feel, therefore, that the formation of the Society for Social Responsibility in Science satisfies a true need. This society, through discussion of the inherent problems, will make it easier for the individual to clarify his mind and arrive at a clear position as to his own stand; moreover, mutual help is essential for those who face difficulties because they follow their conscience."

During the 5 years that have elapsed since, military means of mass destruction have come to denote "weapons [that] threaten the continued existence of mankind" and to imply "the risk of universal death." On this most recent occasion, when Einstein, in the last week of his life, gave his last signature to an appeal, the scientists signing it were speaking no longer as men of science, "not as members of this or that nation, continent or creed, but as human beings, members of the species man, whose continued existence is in doubt" (*1*).

Within a week a similar statement, signed in mid-July by another group of Nobel prize-winning natural scientists, reaffirmed their devotion to the service of science as "a road to a happier life for mankind." Yet, these scientists continue, "we view with horror that this science provides the means to mankind to destroy itself" (*30*). The second warning to all nations that they will cease to exist unless they are ready "to renounce force as a final resort to policy" was to be sent to all other Nobel prize winners for signature—thus echoing the fervent hope three men of vision expressed 40 years ago that such a "collective pronouncement . . . include all those who are esteemed and considered as authorities by their fellow-men" (*19*).

In the four decades here surveyed science has mastered ever more facts, has come still closer to reaching its own limits. But in the process scientists have attained a humility, simplicity, and political consciousness, lacking in most of their elders, which may be needed to prevent history from repeating itself for the very last time.

References and Notes

1. *New York Times*, 10 July 1955, p. 25.
2. The other signers were Max Hermann Baege, Eugene Dietzgen, August Föppl, Georg Ferdinand Helm, Christian Jensen, Wilhelm Jerusalem, Otto Kammerer, Berthold von Kern, Karl Lamprecht, Eduard von Liszt, Georg Elias Müller, Franz Müller-Lyer, Joseph Petzoldt, Henry Potonié, Ludwig Rhumbler, Hugo von Seeliger, Ferdinand Tönnies, Max Verworn, F. Alexander Wernicke, Otto Wiener, and Theodor Ziehen.
3. *Naturw. Rundschau* **27**, 336 (1912).
4. *Arch. Gesch. Phil.* **25**, 502 (1912).
5. *Z. Psychol.* **62**, 159 (1912).
6. *Arch. für Psychiat. Nervenkr.* **50**, 321 (1912).
7. *Riv. Filosofia* **4**, 547 (1912).
8. *J. Phil. Psychol. Sci. Meth.* **9**, 419 (1912).
9. *Phil. Jb. der Görres Ges.* **26**, 419 (1913).
10. *Rev. Sci. Phil. Théologiques* **6**, 621 (1912).
11. *Riv. Filosofia Néo-Scolastica* **4**, 704 (1912).
12. *Rev. Néo-Scolastique de Phil. (Louvain)* **19**, 580 (1912).
13. *Rev. Phil. de la France et de l'Etranger* **76**, 558 (1913).
14. *Z. positivistische Phil.*, Organ der Gesellschaft für positivistische Philosophie, Berlin. 1–2 Jahrgang, 1913–14; Mitt. an die Mitglieder der G.f.p.Ph., at end of each issue.
15. J. Petzoldt, *Z. positivistische Phil.* **2**, 161 (1914).
16. Gesellschaft für empirische Philosophie, Berlin, *Erkenntnis* **1**, 72 (1930–31); O. Neurath, *ibid.* **1**, 311 (1930–31).
17. *Erkenntnis* **1–8** (1930–40). Title varies: 1930–38; *Erkenntnis* **1–7**, *zugleich Ann. Phil.* **9–15** (slight variations); June 1939–April 1940 (**8**), *J. Unif. Sci.* (*Erkenntnis*). "Im Auftrage der Gesellschaft für wissenschaftliche (1930, empirische) Philosophie Berlin und des Vereins Ernst Mach in Wien," 1930–33. Leipzig. June 1939–April 1940, published in The Hague; H. Reichenbach, *ibid.* **1**, 3 (1930–31).
18. J. Jorgensen, *The Development of Logical Empiricism* (Univ. of Chicago Press, Chicago, Ill., 1951).
19. G. F. Nicolai, *The Biology of War* (Century, New York, 1918), pp. xi–xx.
20. ———, *Aufruf an die Europäer; Gesammelte Aufsätze zum Wiederaufbau Europas* (Verlag der Wiener Graphischen Werkstätte, Leipzig, 1921), pp. 21–25.
21. A. Einstein, *The Fight against War* (John Day, New York, 1933).
22. ———, *The World as I See It* (Covici, Friede, New York, 1934); *Out of My Later Years* (Philosophical Library, New York, 1950); *Ideas and Opinions* (Crown, New York, 1954); P. Frank, *Einstein, His Life and Times* (Knopf, New York, 1953); Bibliography, II. Non-Scientific Writings; III. Interviews, Letters and Speeches Quoted in *New York Times*, in P. A. Schilpp, *Albert Einstein, Philosopher-Scientist* (Library of Living Philosophers, Evanston, Ill., 1949), pp. 730–756.
23. A. Einstein and S. Freud, *Why War?* (International Institute of Intellectual Co-operation, Paris, 1933), pp. 11–12. Published simultaneously in German, French, and English.
24. O. Neurath *et al.*, "Internationale Enzyklopaedie der Einheitswissenschaften," *Erkenntnis* **6**, 139 (1936); 3rd Intern. Cong. Unity of Science, Paris, 1937, *Zur Enzyklopädie der Einheitswissenschaft: Vorträge von Neurath, Brunswik, Hull, Mannoury, Woodger* (Van Stockum & Zoon, 's Gravenhage, 1938); H. Feigl, "Selected bibliography of logical empiricism," *Rev. Intern. Phil.* **4**, 95 (1950).
25. *Studium Generale*; Zeitschrift für die Einheit der Wissenschaften im Zusammenhang ihrer Begriffsbildungen und Forschungsmethoden. Heidelberg und Berlin. 1 Jahrgang, Heft 1, October 1947–; M. Thiel, *ibid.* **1**, 1 (1947).
26. V. C. Vaughan, *Science* **36**, 225 (1912).
27. R. v. Mises, *Positivism: a Study in Human Understanding* (Harvard Univ. Press, Cambridge, Mass., 1951), p. 366.
28. "A society for social responsibility in science," *Science* **110**, 460 (1949).
29. A. Einstein, *Science* **112**, 760 (1950).
30. *New York Times*, 16 July 1955, p. 3; *Christian Science Monitor*, 16 July 1955, p. 2.

News of Science

The U.N. and Atomic Energy

The current discussion of the establishment of an international atomic energy agency makes the following abstracts from former President Harry S. Truman's memoirs particularly interesting. In describing his effort in 1945 to get the best possible advice on atomic energy policy, Truman says of one of his cabinet meetings:

"I had asked for a memorandum from Dr. Vannevar Bush, director of the Office of Scientific Research and Development, and one from the Joint Chiefs of Staff. Dr. Bush said he believed a proposal to Russia for exchange of scientific information would open the door to international collaboration in the field of atomic energy and eventually to effective control, the alternative being an atomic bomb race.

" 'The move does not involve "giving away the secret of the atomic bomb." ' wrote Dr. Bush: 'That secret resides principally in the details of construction of the bombs themselves, and in the manufacturing processes. What is given and what is received is scientific knowledge. Under an attempted closed system, and scientific espionage, it is probable that Russia would benefit to a considerable degree by our scientific progress, and we would benefit little by hers. Moreover, we cannot keep scientific secrets from Russia without also keeping them from the major portion of American scientists.'

"The Joint Chiefs of Staff recommended that the United States retain all existing secrets with respect to the atomic weapons."

A little further on Truman discusses atomic energy as follows:

"On Oct. 3 I sent to the Congress a message urging that a national policy for atomic energy be enacted into law.

"Meanwhile, the groundwork had already been laid for international discussions. I invited both Attlee and the Canadian Prime Minister, Mackenzie King, to visit Washington in November.

"Our discussions got under way on Nov. 11. . . . I told the two Prime Ministers that, so far as I could speak for the Government of the United States, I believed that a free exchange of scientific knowledge would be essential to the peace of the world.

"It was my view, I said, that the control of atomic energy for destructive purposes should be lodged in the United Nations, when we had become absolutely sure that the confidence of each nation in the good faith of the other was well founded. This, I suggested, might make it necessary to abandon the veto power in the Security Council.

"Both Attlee and MacKenzie King then gave their views, and I was pleased that they were essentially in agreement with me.

"I gave the Cabinet a detailed account of my conversations with the two Prime Ministers at the Cabinet meeting on Nov. 16 and asked for their comments. Secretary Wallace expressed some doubts about the device of a U.N. commission. Vinson and Clark, in line with the position they had taken at our earlier discussion of atomic energy, wanted to be assured that there was no intention on my part to reveal any of the 'know-how.' All agreed, however, that to refer the problem of atomic energy to the United Nations would give that organization a chance to prove itself."

Medical Education, 1954–55

■ American medical schools set all-time enrollment and graduation records in 1954–55, but they may face a student recruiting problem in the next few years, according to a report by the American Medical Association. Prepared by the AMA's Council on Medical Education and Hospitals, the 55th annual report on medical education states that 1954–55 was a year of "steady progress" in various phases of medical education.

An enrollment problem may result because the number of applications to medical schools has been decreasing for the past 5 years. However, the decrease this year was smaller, and it is hoped that a plateau has been reached. In the meantime, some schools may have difficulty in filling all available openings with qualified students.

Only 16.8 percent of the entering class in 1954–55 had an "A" college record, while 69 percent had "B," and 14.2 percent had "C." There were 6977 physicians graduated last year from 75 approved 4-year medical schools. This is the sixth consecutive year that a graduation record has been set.

Next year's class probably will be slightly smaller. However, the report said any decrease will be "only an incident" in a continually expanding number of graduates in years ahead, since classes scheduled for graduation in subsequent years are somewhat larger than next year's. Seven more schools will be graduating physicians by 1960.

Four are new schools just opened or in various stages of development: Albert Einstein College of Medicine at Yeshiva University, New York; the University of Miami Medical School, Coral Gables, Fla.; Seton Hall College of Medicine, Jersey City, N.J.; and the University of Florida School of Medicine, Gainesville, Fla. The other three are 2-year basic medical science schools that are expanding their programs to 4 years: the University of Mississippi School of Medicine, Jackson, Miss.; the University of Missouri School of Medicine, Columbia, Mo.; and the West Virginia University School of Medicine, Morgantown, W. Va.

Eighty-two percent of the first-year class in 1954–55 will be liable for military service on completion of medical school and internship training. Seventy-three percent of the class graduated in June 1955 was liable for such service. Total enrollment in American medical schools during 1954–55 was 28,585, an increase of 356 over the preceding year. Approximately two-thirds of the increase is accounted for by the addition of the University of California School of Medicine, Los Angeles, to the approved list.

The entering class of 7576 students was the largest ever enrolled in the nation's medical schools. This was an increase of 127 over the preceding year. Half of the increase in the entering class was accounted for by the addition of a first-year class at the newly approved California school.

The report also said that projected 1955–56 budgets show there has been a "modest improvement" in medical school financing. Approximately 95 percent of the support for research now conducted in medical schools is made possible by grants-in-aid from outside agencies.

Estimates for 1955–56 indicate that outside agencies will give about $54.5 million to medical schools for the support of research activities and slightly more than $7 million for special teaching programs. This is in addition to the estimated $98 million from tuition, endowment income, legislative appropriation, gifts, and grants that support the basic teaching programs.

More than $2 million was given to medical schools during 1954 by the National Funds for Medical Education. This fund is supported by business and

industry and by physicians who contribute to the fund through the American Medical Education Foundation. The AMA annually gives a direct contribution to the foundation.

During 1954–55, completed construction by medical schools had a value of more than $99 million and construction initiated had a value of more than $80 million. In addition, many hospital and clinic facilities used in teaching were financed by Government or private funds and not by the schools.

Among other items discussed in the report, which appeared in the 8 Oct. *Journal of the American Medical Association,* are the following:

There are 251 faculty vacancies reported for the 1955–56 session—seven less than in 1954–55. In view of the new schools and new faculty appointments, this slight improvement is perhaps more significant than it appears, the report said.

There were 1537 women attending medical school. This was a slight increase over the previous year. The 345 women graduates was the smallest number since 1947.

The year also witnessed the largest recorded attendance—105,466—at 1719 short courses, conferences, assemblies, seminars, and study and circuit courses for practicing physicians who wished to obtain additional training.

News Briefs

■ Electric wiring exposed for long periods of time to atomic rays from nuclear power may show various effects. In some types the insulation will break down, whereas others will show no ill effects, and some varieties will even improve. These observations were described by P. H. Klein and Clifford Mannal of the General Electric Company in a report delivered at the recent meeting in Chicago of the American Institute of Electrical Engineers.

For doses up to 10^8 roentgens, polyethylene tape and Formex wire enamel undergo discernible decreases in their resistance to short-time voltage breakdown. Cellulose acetate shows little change under the same conditions, and polyvinyl chloride shows some distinctly favorable alterations after irradiation. Mica-and-glass tape impregnated with silicone resin—an inorganic insulator—is virtually unaffected, even at radiation levels up to 10^{10} roentgens.

■ It is hoped that Britain's rabbit population, which was once 100 million, will be reduced to 3 million next year with the continued spread of the rabbit disease, myxomatosis, across the country. Derick H. Amory, Minister of Agriculture, has reported that since the disease took hold 2 years ago, the grazing season has been lengthened considerably, and crop yields in some places have been increased by 50 percent. He estimates that farmers have been saved approximately $42 million a year.

It is also reported that a strain of myxomatosis-resistant rabbits has appeared in an area of Nottinghamshire. Efforts are now being made to wipe them out.

■ A central laboratory building at Suffield Experimental Station, Suffield, Alberta, Canada, opened officially on 29 Sept. Facilities of the 1000-square-mile establishment, the Defence Research Board's largest station, are employed for experimental activities related to the defensive aspects of biological, chemical and radiological warfare. The staff scientists work closely with the Canadian Armed Forces and colleagues in the same fields in the United Kingdom and the United States.

The laboratory also accommodates station headquarters, the scientific administrative staff, a Canadian Army liaison office, a library, and other auxiliary services associated with the establishment's program. A conference room and a projection room will be used extensively for scientific discussions and films of trials and research and development techniques.

The $1.5 million building contains a diversified range of scientific installations. One is an electron microscope with a magnification of 20,000. In a nearby building associated with the central laboratory is a 2-million-electron-volt Van de Graaff generator.

■ Discovery of a new antibiotic in an organism obtained from East Pakistan earth was announced in the 1 Oct. issue of *Nature* by K. Ahmad and M. F. Islam of the University of Dacca, East Pakistan. The antibiotic has been named *ramnacin* after the place, Ramna, where the organism producing it was discovered. This organism is a *Streptomyces. Ramnacin* is a stable antibiotic showing activity against a number of bacteria, including some staphylococcus and streptococcus germs and two fungi.

■ Recently a Japanese seismologist, Takahiro Hagiwara, pointed out on his return from a 2-year UNESCO mission in Turkey that it may be possible to forecast earthquakes. Working under the UNESCO Technical Assistance Program, Hagiwara cooperated with the Turkish Government in establishing a Seismological Institute at Istanbul and three earthquake observation stations in other parts of Turkey, which is struck by earthquakes on an average of once a year. By correlating reports from these stations and from others all over the world, Hagiwara observed that it might be possible "to find a method of forecasting earthquakes so that people can be warned in time . . ."

The international cooperation that is required if earthquakes are to be understood, and perhaps forecast, is exemplified by the UNESCO project in Turkey. G. Gutenberg of California was in charge of the preliminary survey; preceding Hagiwara in Turkey were F. J. Roesli of Switzerland and M. Gaston Grenet of France.

■ Hormones circulating in the body of an expectant mother can cross into the unborn baby's body and there affect the baby's organs. This finding, which is contrary to current belief, was announced by William B. Ober, Charles C. Roby, Jay Bernstein and James E. Drorbaugh of Boston Lying-In Hospital at the recent meeting in Boston of the American Society of Clinical Pathologists.

■ After the Atomic Energy Commission turned over 961 papers on possible industrial uses of atomic energy to the Commerce Department's Office of Technical Services, sales by the office jumped about 400 percent.

Scientists in the News

ROBERT G. SPROUL was honored for his 25 years as president of the University of California with a Symposium on the Physical and Earth Sciences that was held 17–19 Oct. on the Berkeley campus as part of a state-wide commemoration of the anniversary.

It was during this symposium that Ernest O. Lawrence, Nobel laureate, inventor of the cyclotron, and director of the university's Radiation Laboratory, announced the discovery of a new atomic particle, the antiproton.

ELIZABETH L. HAZEN, microbiologist, and RACHEL BROWN, biochemist, of the division of laboratories and research of the New York State Department of Health, have received the $5000 Squibb award in chemotherapy for their discovery of nystatin, the first antifungal antibiotic safe enough for human use. The microorganism that produces nystatin was found by Hazen in a soil sample obtained from a farm near Warrenton, Va. The isolation of the active drug was carried out by Brown.

The discovery of nystatin resulted from a search started in 1946. Although many scientists were then screening soil samples for microorganisms possessing antibiotic activity, few, if any, were concentrating on antifungal agents.

Hazen examined soil samples from all parts of the United States, but it was not until 1948 that the microorganism that produces nystatin was discovered. That summer Hazen spent her vacation in Warranton, visiting the dairy farm of W. B. Nourse, who became interested in her research and helped her collect soil samples.

It was the sample taken nearest to the Nourse dairy barn, at the edge of the cow pasture, that yielded the nystatin-producing microorganism. Found to be a member of the genus *Streptomyces* and believed to be a new species, the organism was named *Streptomyces noursei* by Hazen in honor of her host. The name *nystatin* is derived from the words *New York State*.

Brown entered the project because of her previous experience in the extraction of active antibiotic ingredients from bacterial cultures. The extraction phase of the work presented difficulties, and many solvents were tried before one capable of performing the extraction was obtained. Brown then discovered that she had unknowingly extracted not one but two antifungal antibiotics. One was nystatin and the other a variety too toxic for human use.

BERNARD HOUSSAY, Nobel prize winner, has been reinstated as professor and director of the Physiological Institute in Buenos Aires University. Houssay was discharged from his post for disagreeing with former President Juan D. Peron's education policies.

KARL F. HEUMANN, for the past 3 years director of the Chemical-Biological Coordination Center at the National Academy of Sciences–National Research Council, has resigned to accept a position with *Chemical Abstracts* at Ohio State University.

GEORGE A. LIVINGSTON, who has been associated with the center since June 1953, was named acting director of the center on 1 Sept.

MAURICE HOLLAND, New York industrial research adviser to industry, foundations, and governments, was presented with a special Founder's award by the Industrial Research Institute during its recent fall meeting in Houston, Tex. He was honored for his services in originating the institute and for his contributions to industrial research and to the institute.

S. E. GOULD, editor-in-chief of the *American Journal of Clinical Pathology* for 10 years, has resigned this position effective 31 Dec. He will be succeeded by PARKER R. BEAMER, professor of pathology at Indiana University Medical School.

PAUL EMMETT, professor of chemistry at Johns Hopkins University and an expert in catalysis, has been named 1955 Baker lecturer in chemistry at Cornell University. Between 8 Nov. and 15 Dec., Emmett will lecture on "Current ideas on contact catalysis" each Tuesday and Thursday in Baker Laboratory.

CHARLES F. KETTERING, research consultant and a director of the General Motors Corporation, is to receive the 1955 Hoover medal for "great, unselfish, nontechnical services by engineers to their fellow-men." The presentation will be made at the diamond jubilee celebration and dinner of the American Society of Mechanical Engineers in Chicago, Ill., on 17 Nov.

Kettering, who has retired as vice president and general manager of the research laboratories division of General Motors, is now chairman of the Charles F. Kettering Foundation. He is directing research on chlorophyll and photosynthesis, artificial fever therapy, and cancer.

GEORGE F. KIRBY, who joined the Ethyl Corporation, New York, as a chemist 15 years ago, has been elected vice president in charge of research and engineering. He succeeds B. BYNUM TURNER, who has been elected executive vice president, a new position.

FRANCIS J. SERGEYS, director of the chemical engineering division, has been promoted to general manager of research and engineering operations at Baton Rouge, La., and Houston, Tex., to succeed Kirby. PAUL A. MCKIM, assistant director of process development, will assume Sergeys' post.

RUTH RHINES, a neuroanatomist who served last year as an associate in medicine at the University of Pennsylvania School of Medicine, has been appointed associate professor of anatomy in the University of Chicago division of biological sciences.

In the same division, WILLIAM K. BAKER, a geneticist and formerly a senior biologist with Oak Ridge National Laboratory in Oak Ridge, Tenn., has been named associate professor.

M. STARR NICHOLS, assistant director of the Wisconsin State Laboratory of Hygiene and professor of sanitary chemistry at the University of Wisconsin, has received the Charles Alvin Emerson medal from the Federation of Sewage and Industrial Wastes Association. The citation said: "You have earned this signal honor through your many years of devoted and unselfish service toward the work of the Federation." Nichols and his associates developed a test in stream pollution studies, called the biochemical oxygen (BOD) test, that is now a standard procedure in all parts of the United States.

The federation's Harrison Prescott Eddy medal for outstanding research in the field of sewage waste treatment was awarded jointly to Gerard A. Rohlich of the University of Wisconsin civil engineering department; William L. Lea of Madison, Wis., director of the division of industrial hygiene of the Wisconsin State Board of Health; and William J. Katz, sanitary engineer in the research department of the Chain Belt Co., Milwaukee, Wis. The three engineers studied the removal of phosphates from treated sewage when Lea was an assistant professor of civil engineering at the university and Katz was a graduate student completing his doctor's degree in civil engineering under Rohlich's supervision.

CARL J. WIGGERS of Cleveland, Ohio, has received the 1955 Albert Lasker award of the American Heart Association for "distinguished achievement in the field of cardiovascular research." Wiggers, who is one of the greatest contemporary authorities on the physiology of the heart and blood vessels, is editor of *Circulation Research*, the AHA's journal of fundamental studies.

JOSEPH GABERMAN, a psychologist, has for several years been involved in an unusual security case. The unique aspect of Gaberman's case is that the Navy has cleared him for retention of his reserve officer's commission, but has dismissed him from his Navy civilian post on loyalty-security grounds. The charges involve his associations of more than 20 years ago and the left-wing connections of relatives. He is now attempting to get back his civilian job.

ALFRED L. BOEGEHOLD, assistant to the vice president in charge of the General Motors research staff, has received the American Society for Metals 1955 gold medal "in recognition of his great versatility in applying science to the metal industry."

JOHN G. DOUGLAS, having retired from the Mene Grande Oil Co. at Maracaibo, Venezuela, has accepted a position as associate professor of geology at the University of Mississippi.

SAMUEL R. M. REYNOLDS, director of the department of embryology at the Carnegie Institution of Washington, has been appointed professor and head of the department of anatomy at the University of Illinois Chicago Professional Colleges, effective 1 Jan. Reynolds' appointment fills the vacancy created when Arthur Kirschbaum resigned in 1954 to head the anatomy department at Baylor University College of Medicine.

Necrology

WALTER N. BROWN, JR., University Park, Pa.; 37; physicist, director of Bone density Research and Evaluation Center at Pennsylvania State University; 12 Sept.

JOHN PIM CARTER, Philadelphia, Pa.; 75; anthropologist, staff member of the Academy of Natural Sciences of Philadelphia; 22 Oct.

JACOB LANGTHORN, Mount Dora, Fla.; 88; retired consulting engineer; 23 Oct.

IVAN MCDOUGLE, Baltimore, Md.; 63; professor of sociology at Goucher College; 25 Oct.

ROSS MARRIOTT, Swarthmore, Pa.; 72; astronomer, professor emeritus of mathematics at Swarthmore College; 19 Oct.

MORRIS NEWMAN, Teaneck, N.J.; 28; assistant professor of chemical engineering at New York University; 21 Oct.

RICHARD PAGET, London, England; 86; authority on speech and artificial speech production and specialist in the languages of the deaf and dumb; 23 Oct.

J. SPEED ROGERS, Ann Arbor, Mich.; 62; professor of zoology and director of the museum of zoology at the University of Michigan; 17 May.

JAMES W. SMITH, New York, N.Y.; 62; eye surgeon and clinical professor of ophthalmology at the Post-Graduate Medical School of New York University-Bellevue Medical Center; 24 Oct.

Education

■ Donald L. Benedict, director of Stanford Research Institute's physical sciences division, has announced the formation of a new department of chemical physics under his supervision. The department takes over functions of the former basic engineering sciences group that was until recently a part of the engineering division. Named to head the new department is Clinton M. Kelley, former head of the group in engineering.

■ Meharry Medical College, Nashville, Tenn., and North Texas State College, Denton, Tex., have been elected to membership in the Oak Ridge Institute of Nuclear Studies, which is now owned by 34 southern universities.

Other action during recent meetings of the ORINS council and board of directors included the election of Marten ten Hoor, dean of the College of Arts, University of Alabama, to a 3-year term as chairman of the council, which is composed of one representative from each of the member universities. W. M. Nielsen, chairman of the department of physics, Duke University, was named to a 1-year term as council vice chairman.

As council chairman, Ten Hoor automatically becomes a member of the 15-man board of directors, other new members of which are J. M. Dalla Valle, professor of chemical engineering, Georgia Institute of Technology; W. V. Houston, president of Rice Institute; Charles E. Dunlap, chairman of the department of pathology, Tulane University School of Medicine; C. C. Pfeiffer, chairman of the department of pharmacology, Emory University School of Medicine; Alvin M. Weinberg, director of Oak Ridge National Laboratory.

Reelected to 1-year terms are Paul M. Gross, vice president of Duke University, president of the corporation; Clifford K. Beck, professor and head of the department of physics, North Carolina State College, vice president; and William G. Pollard, ORINS executive director, corporation treasurer.

■ The School of Engineering at North Carolina State College now offers a degree of bachelor of metallurgical engineering. The new curriculum will complement others in ceramic and geological engineering in the college's department of mineral industries.

■ A new department of geography has been created at Michigan State University; it will offer an undergraduate and a master's degree.

■ The U.S. Civil Service Commission has announced a college student work-study program for scientific and technical personnel within the Potomac River Naval Command and other Federal establishments in Washington, D.C., and the nearby area. In this cooperative education plan, a student alternates at designated intervals during the year between academic college instruction while in residence at a participating college, and work-experience training at one of the Federal establishments.

Salaries range from $2690 to $3415 per year. Applicants who wish to be scheduled for the first written test to be held on 5 Dec. 1955 must have their Form 5000-AB on file *by 15 Nov.*

■ High-school seniors throughout the country have been invited to compete for prizes and honors offered by the sponsors of the 15th annual Science Talent Search. Winners, selected from entrants from participating public, private, and denominational schools, will share $11,000 in Westinghouse Science Scholarships.

Awards will be made in Washington, D.C., early next spring at a 5-day Science Talent Institute which the 40 finalists in the competition will attend as guests of the sponsors. The young scientists will have the opportunity to exhibit their work at the institute and to participate in discussions with some of the nation's leading scientists.

The boy or girl whose all-around Science Talent Search performance and whose personal qualities are judged the most outstanding will receive a $2800 grand science scholarship. Other scholarships ranging from $100 to $2000 will be awarded to the remaining 39 finalists. In addition, 260 other students who show "excellent promise of becoming creative scientists" will receive honorable-mention citations.

The awards are made by Westinghouse Educational Foundation, which is supported by Westinghouse Electric Corporation. The talent search is conducted by Science Clubs of America, which is administered by Science Service.

Entrants must report on an original science project and take an aptitude examination. Their schools then submit scholastic records and teachers' estimates of the entrants' ability. To be eligible, entries must be received in Washington *by midnight, 27 Dec.*

■ Bennington College has announced three new science courses specifically designed for students with no special interest in the natural sciences. A course entitled "Science and symbols" will deal with a sequence of problems in chemistry whose solution historically necessitated the development of a scientific language and method. A physics course will deal with the modern physicist's understanding of the universe, and conceptual structure of physics and its experimental bases, and the potentialities and limitations of the scientific method. The third course is "Mathematics in Western culture."

Grants, Fellowships, and Awards

The trustees of Colonial Williamsburg, Williamsburg, Va., have issued the following announcement:

"As part of its program to bring new strength in our time to the belief in human liberty and the dignity of the individual which made Williamsburg and its leaders a moving force in 18th century America, Colonial Williamsburg has established The Williamsburg Award. The Award will be made, as occasion warrants, to a person who in the course of contemporary events has made an outstanding contribution to the historic struggle of men to live free and self-respecting in a just society. If circumstances require, it may be made jointly to two or more persons. It will carry an honorarium of $10,000 and an appropriate emblem.

"The only limitation on eligibility for the Award will be clear and eminent achievement. Recipients may be natives

of any land, reside in any country, work at any occupation, be members of any race.

"The Trustees of Colonial Williamsburg hope that The Williamsburg Award will serve not only as an honor to the recipients, but also as an encouragement to men and women everywhere to seek liberty and justice for themselves and all men. The purpose of the Award is to serve as a continual reminder that there are today, as there were yesterday, vigorous, courageous and eloquent leaders."

■ The National Foundation for Infantile Paralysis announces that 56 students have been awarded scholarships for the current year to complete their education in medical social work. The total number of medical social work scholarships awarded by the foundation since 1944 is now 681, for which almost $1 million has been authorized to date. The present scholarship recipients are residents of 24 states and are studying in 19 of the schools of social work that offer an approved curriculum in medical social work.

■ The Fellowship Office of the National Academy of Sciences–National Research Council is now accepting applications for two postdoctoral fellowship programs in the natural sciences for the academic year 1956–57.

American Chemical Society petroleum research fund postdoctoral fellowships. Supported by the American Chemical Society, these fellowships are designed to be used exclusively for advanced scientific education and fundamental research in the petroleum field. The term *petroleum field* as used comprises (i) exploration for, and the production, transportation, and refining of, petroleum, petroleum products, and natural gas, and (ii) the production and refining of substitutes for petroleum and petroleum products from natural gas, coal, shale, tar sands, and like materials. Applicants must produce evidence of training in one of the natural sciences equivalent to that represented by the Ph.D. or Sc.D. degree and must have demonstrated superior ability for creative research. These fellowships are open only to citizens of the United States.

Merck senior postdoctoral fellowships in the natural sciences. These senior fellowships are supported by Merck and Co., Inc., and are awarded for the purpose of giving advanced education, training, and development to individuals who have demonstrated marked ability in research in the physical, chemical, or biological sciences and who wish to broaden their fields of investigational activity by acquiring some familiarity with another area. Applicants must produce evidence of training in physics, chemistry, or biology equivalent to that represented by the Ph.D. degree, and must have had at least 3 years of postdoctoral experience in their major field, only one of which may have been fellowship work. These senior fellowships, with no age restrictions, are open only to citizens of the United States.

Detailed information and application forms may be secured for either of these programs by writing to the Fellowship Office, National Academy of Sciences–National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C. Fellowships are awarded about the middle of March. All applications must be *postmarked on or before 1 Dec.*

■ The department of geology and geophysics of Massachusetts Institute of Technology and the Geophysical Laboratory of the Carnegie Institution of Washington are cooperating in the award of predoctoral fellowships in theoretical and experimental geology. The awards are to be known as the Vannevar Bush fellowships in earth sciences, in honor of Bush, who long served as professor, and later as dean and vice president, at M.I.T. and more recently as president of the Carnegie Institution of Washington. Candidates for an award must have advanced training in mathematics, physics, and chemistry, and a broad knowledge of the earth sciences. Recipients will have unusually favorable opportunities to do thesis work on challenging new problems in the most active and rapidly moving fields of earth science.

Applicants for the award must have completed all M.I.T. requirements for the Ph.D. degree except thesis; they will be registered as full-time doctoral candidates at M.I.T. during that part of their graduate study in which they are in residence at the Geophysical Laboratory. The fellowship will be awarded for the period required by the recipient to complete his laboratory work at the Geophysical Laboratory, and the subsequent time required at M.I.T. for analyzing and correlating the data and completing the dissertation. In general, fellows should expect to spend at least three or four terms in Washington and one or two terms in Cambridge.

While at the Geophysical Laboratory, the fellow will receive $200 per month (plus appropriate tuition) for the first 12 months and $225 per month (plus tuition) for the duration of the fellowship. Upon returning to M.I.T., the recipient will continue to receive the same monthly stipend as he last received from the Geophysical Laboratory, in addition to tuition. At all stages of his work, the fellow will be registered at M.I.T. as a full-time doctoral candidate and will work under the close supervision of at least one faculty member of the M.I.T. department of geology and geophysics.

Any graduate student interested in preparing for competition for the awards should write to the Chairman, Department of Geology and Geophysics, 24–302 M.I.T., Cambridge 39, Mass., for information about entrance requirements and possible financial assistance while meeting M.I.T. requirements.

■ The department of meteorology of Florida State University has announced the availability of graduate assistantships for the academic year 1956–57. Any candidate for the M.S. and Ph.D. degree in meteorology and climatology is eligible to apply. No previous meteorological education is necessary, but the applicant's undergraduate education must have included at least 1 year of calculus and 1 year of physics.

A graduate assistantship carries a stipend of $1680 per calendar year for a student holding a bachelor's degree and a stipend of $1980 for a student holding a master's degree in meteorology. The student is permitted to carry 10 hours of course work. Assistants pay resident fees of about $75 per semester. Out-of-state tuition is waived.

Most assistants will be expected to participate in research projects being pursued under sponsorship of the Air Force Cambridge Research Center, the Office of Naval Research, and the Weather Bureau. Primary research fields are synoptic meteorology, theoretical meteorology, tropical meteorology and theoretical climatology.

Applications for assistantships should be filed *before 15 April 1956.* Later applications will be considered if funds are available. For further information and application blanks, write Dr. Werner A. Baum, Department of Meteorology, Florida State University, Tallahassee, Fla.

■ A graduate program in biophysics that leads to either the M.S. or Ph.D. degree has been established by the Sloan-Kettering Division of the Cornell University Medical College. The M.S. program is devoted specifically to radiation physics and includes training in clinical radiological physics, medical and research applications of radioisotopes, and health physics.

Extensive facilities in the Sloan-Kettering Institute and Memorial Hospital are available for research on thesis problems in various physical, chemical, or biological effects of different qualities of radiation. Related courses can also be scheduled at neighboring universities. A limited number of fellowships is available. Further information may be obtained by writing to Dr. J. S. Laughlin, Department of Biophysics, 410 E. 68 St., New York 21.

In the Laboratories

■ The Hercules Powder Company of Wilmington, Del., has announced that it will build a new technical information center at its Experiment Station, Lancaster Pike, to cost approximately $1 million. The 35,000 square feet of floor space in the new structure will make it possible to centralize in one location all facilities of Hercules' technical information division. In addition, it will include the Experiment Station's library, which at present contains 10,000 volumes.

Hercules' technical information division provides many services for the technical staff of the Experiment Station and other company units. It contains more than 500 scientific periodicals, 7000 bound journals, maintains a correspondence file of 30,000 letters, and receives and indexes several thousand technical reports each year. The division also provides a translating service for technical personnel.

■ Construction has begun on the new main plant for Houston Technical Laboratories, geophysical instrumentation subsidiary of Texas Instruments Inc., Dallas. When the building is completed next spring, H.T.L. will be able to consolidate the research, design, and manufacturing operations that are now being carried on in several rented buildings in Houston.

■ North American Aviation, Inc., Los Angeles, Calif., has announced a college-level educational program for children of employees. Ten annual scholarships will provide payment of the students' tuition and other required nonrefundable fees up to a maximum of $650 a year.

In addition, each scholarship student will receive an expense allowance of $400 a year. In recognition of the fact that the tuition fees established by most private colleges and universities are insufficient to cover the actual costs of a college education, the plan further provides for the allocation of a $500 annual unrestricted grant to the institution concerned for each student in attendance.

■ The Du Pont Company has announced plans for the construition of a plant at Beaumont, Tex., for the manufacture of Hypalon, a synthetic rubber. The company's Beaumont Works started operation a year ago with the manufacture of methionine, an amino acid used as a poultry feed supplement. Hypalon is a chlorosulfonated polyethylene.

■ A contract for new construction required in the expansion of the Atomic Energy Commission's Rocky Flats plant near Denver, Colo., has been awarded the Swinerton and Walberg Company of San Francisco, Calif., and Denver, Colo. The project involves two new buildings and related facilities, modification of three existing buildings, and installation of equipment. The estimated total cost is $13.5 million. The Catalytic Construction Company of Philadelphia, Pa., is the architect-engineer. The Rocky Flats plant is operated for the AEC by the Dow Chemical Company of Midland, Mich.

■ Last month the General Electric Company, Schenectady, N.Y., formally opened a new analytical chemistry laboratory. The laboratory is a major addition to the company's General Engineering Laboratory, and as such is a part of that unit's $1.4 million expansion program.

Miscellaneous

■ The Middle East Institute is initiating an annual survey of research in progress on the Middle East. The geographical limits are the Arab countries, Israel, Turkey, Iran, Afghanistan, North African countries, Sudan, Ethiopia, and Eritrea; the disciplinary limits are the social sciences and appropriate aspects of related fields (for example, law and Islamics, art, linguistics, archeology). There are no chronological limits.

All those engaged in research on the Middle East are urged to submit the following information: name; address; topic of investigation; sponsoring organization (if any); estimated date of completion; plans for publication; and pertinent comments on the nature of the research, sources being used, and method of approach. Please address correspondence to: Survey of Research, Middle East Institute, 1761 N St. NW, Washington 6, D.C.

■ Volume I of the *Proceedings of the Eighth Pacific Science Congress* of the Pacific Science Association (Philippines, November 1953) was issued by the National Research Council of the Philippines in July 1955. This illustrated volume includes officers, organization, attendance, plenary sessions, resolutions, meetings of the Pacific Science Council, and other material.

The constitution of the association as amended by the council at the eighth congress is reprinted, and there is a listing of the standing committee members who will serve between the eighth and ninth congresses. The volume also contains the lectures by von Koenigswald, Beyer, Bruun, Macdonald, van Steenis, Salcedo, Li Chi, Ranson, Wharton, and Murphy. This 463-page work may be obtained from the National Research Council of the Philippines, University of the Philippines, Quezon City, Philippines.

■ The Commonwealth Scientific and Industrial Research Organization is planning to publish the proceedings of the International Wool Textile Research Conference that was held recently in Australia. These proceedings will include a large proportion of original work not published elsewhere, in a series of five volumes as follows: volume A—*Histology of Wool and Hair and of the Wool Follicle*; volume B—*Chemical Physics and Physical Chemistry of Wool and Proteins*; volume C—*Chemistry and Biochemistry of Wool, Proteins, Peptides, and Amino Acids*; volume D—*Physics of Wool and other Viscoelastic Fibres;* volume E—*Wool Technology.*

A limited edition is being printed for a selected distribution and for subsequent sale at £25 per set of five volumes. However, the C.S.I.R.O. is making a special prepublication offer of £10 (Australian) for the set of five volumes or £2 per volume for volumes A to D and £4 for volume E.

This special price is possible only if orders are submitted before printing commences. Subscribers may send orders, *not later than 30 Nov.*, to the Secretary (General Administration), C.S.I.R.O., 314 Albert St., East Melbourne, Victoria, Australia.

■ A bronze portrait of ALBERT SCHWEITZER was presented to the Smithsonian Institution on 12 Oct. by Leo Cherne, sculptor and president of the Research Institute of America. Leonard Carmichael, secretary of the Smithsonian, received the portrait at ceremonies held at the Smithsonian Building in the presence of friends and associates of the donor and officials of the Institution.

The bronze is 13 inches high and was modeled by Cherne from photographs after he had returned from Viet-Nam depressed by the condition of the children, women, and aged adults of the displaced population and mindful of the great humanitarian work of Schweitzer as a medical missionary among the native populations of Africa.

■ The first issue of *Medical News*, a newspaper exclusively for the medical profession, appeared on 12 Sept. CIBA Pharmaceutical Products, Inc. of Summit, N.J., distributes the 8-page tabloid-size newspaper free of charge to physicians every other week. However, the editorial content of the publication is not governed by CIBA's interest as a pharmaceutical manufacturer.

Blake Cabot will serve as executive editor of *Medical News*. Cabot is the author of *The Motion of the Heart*, a book on cardiovascular research, and during the past 15 years has written many articles on medical research and public health.

Reports and Letters

Genetic Recombination in Bacteria

In the issue for 12 Aug. *Science* (p. 278) reported on the work of Wollman and Jacob on genetic recombination in *Escherichia coli*. This work concerned the effects of mechanical disruption of mating cultures on the patterns of segregation. The authors interpreted their results in terms of fractional fertilizations by broken gametic units, whose passage into the fertilized bacterium is specifically polarized. The news report further correlated this effect with virus-mediated genetic transduction. These findings are extremely interesting, but a report on a single article cannot take the space to discuss diverse interpretations. This danger is underlined by the fact that previous news summaries [*Science* **118**, 66 (17 July 1953)] have reported claims that recombination in *E. coli* K-12 depends on an F^+ "virus" that acts as the vector; the present article refers to "mating pairs" and could not discuss the evolution in hypotheses. This letter is intended as an extension of the remarks of the news report that presents a more complete picture.

Transduction, as the term was defined when first introduced, is the transfer of a fragment of genetic material by phage or any other agency; fertilization implies the union of whole genomes or nuclei. Intermediate categories of genetic exchange may be found to occur naturally, or as suggested by the current article, may be artificially produced. For example, fractional fertilizations (or postzygotic losses with the same effect) have been indicated in frog eggs by sperm treated with toluidine blue [R. Briggs, *J. Gen. Physiol.* **35**, 761 (1952)] and this might be speculated on as one approach to the achievement of genetic transduction in higher organisms. However, the artificial interruption of fertilization serves, if anything, to emphasize the completeness of the normal process and the consequent distinction between fertilization and transduction mechanisms.

Unfortunately, the true constitution of the fertilized cell cannot be inferred with certainty from data on haploid segregants, owing to peculiarities of the meiotic mechanism in *E. coli* K-12. In the cited experiments, fertilization might have been incomplete, or it might have been complete with later disturbances of chromosome pairing to account for the segregation effects. Furthermore, if fertilization were fractional, the gradient of recovery of various loci might be due, as proposed, to the preferential orientation of gametic chromosomes, or to dependence on one locus (a centromere?) for the completion of synapsis, crossing-over and segregation.

These limitations of inference are equally applicable to undisturbed matings and have provoked a diversity of hypotheses that share the concept that the Hfr or F^+ gametes are normally incomplete and variable in their genetic content. However, all the experimental data on haploid segregants are equally consistent with a second hypothesis that fertilization is regularly complete, but is coincident with chromosome breakage at specific, predetermined points on the F^+ chromosome, so that certain segments are deleted after meiosis. Even small deletions would be lethal in haploid segregants and would influence the entire segregation pattern.

The most direct means of analyzing the intermediate processes of recombination and deciding between these conflicting viewpoints lies in the behavior of nondisjunctional types, which have been found both for sexual fertilization (heterozygous diploids) and a phage-mediated transduction (heterogenotes) in *E. coli* K-12. Thus the heterogenotes have helped to clarify the nature of the fragments in transduction, while the heterozygotes support the second hypothesis that in sexual recombination, the losses are postzygotic. The evidence is that the losses sometimes involve segments of the F^- rather than the F^+ or Hfr chromosome, or even cross-overs between them, and must therefore be preceded by complete fertilization, synapsis, and crossing-over. When the chromosomes are first broken is not known, and this may occur in the Hfr gamete, although the losses ordinarily (perhaps not always) occur later, after meiosis. However, the heterozygotes have so far shown no evidence of variability in the loci of breaks, for some loci are regularly eliminated—that is, they appear in the hemizygous state—while others are always intact—that is, heterozygous or, by crossing-over, homozygous).

In this light, mechanical stresses might be thought to create additional breaks in the migratory chromosomes, to accelerate the loss of previously broken segments, or to alter their pairing ability. The concept of mechanical breakage of gametic chromosomes in transit is eminently plausible and deserves to be tested in other experimental materials. However, in view of the ambiguity of haploid analysis, nondisjunctional types should be looked for. If the hypothesis of fractional fertilization is correct, interrupted matings should lead to "diploids" that carry variable fragments of the Hfr genome, in contrast to the regular elimination types found from undisturbed matings. The documentation for these remarks may be found in another review [*J. Cellular Comp. Physiol.* Suppl. 2, 75 (1955)].

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Department of Genetics,
University of Wisconsin, Madison

5 October 1955

Chromatographic Fractionation of Normal Adult Oxyhemoglobin

The chromatographic separation of different human carboxyhemoglobins by Prins and Huisman (*1*) and of carboxyhemoglobins of different species by Boardman and Partridge (*2*) has recently been reported. The application of column chromatography to oxyhemoglobin in our laboratory has shown that not only different types of hemoglobin can be separated but also that normal adult hemoglobin itself can be resolved into at least three components (*3*).

Indications of the nonhomogeneity of normal adult hemoglobin have appeared from time to time in the literature. Various techniques, including solubility (*4*), resistance to alkaline denaturation (*5*), and gasometric determinations (*6*), have been used for this purpose. Therefore, it seemed probable that the differences implied by these techniques could be great enough to permit separation of the distinct molecular species in a suitably sensitive chromatographic system. Prelimi-

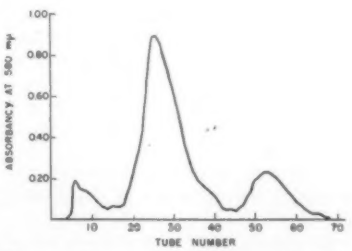

Fig. 1. Chromatogram of normal adult oxyhemoglobin.

nary work in our laboratory (*7*), as well as the work of Boardman and Partridge (*8*), suggested that the ion-exchange resin IRC-50 might be used in such a way.

To prepare the hemoglobin solutions, fresh normal human adult erythrocytes were washed three times with isotonic saline, ruptured with 4 vol of distilled water and 0.1 vol of toluene and centrifuged. The supernatant hemoglobin solution was removed and centrifuged again, this time at 20,000 *g* for 1 hr, in order to insure complete freedom from stroma and other particulate matter. This solution was dialyzed against dilute phosphate-citrate (McIlvaine) buffer (0.03*M*) at *p*H 6.3. One volume of this solution, containing about 50 mg of hemoglobin, was carefully layered on a column of ion-exchange resin IRC-50 that was 50 cm long and 0.9 cm in diameter. The resin had previously been equilibrated with the 0.03*M* buffer. The hemoglobin solution was allowed to enter the resin bed at its own rate of flow. This required 20 to 30 minutes. The hemoglobin was eluted with phosphate-citrate buffer at *p*H 6.3 of constantly increasing strength from 0.03*M* to a maximum of 0.2*M*. The eluant was collected by means of an automatic fraction collector. Each tube collected contained 4.2 ml. The rate of flow was approximately 10 ml/hr. The entire procedure was carried out in a constant-temperature cold room at 4°C.

Figure 1 shows a typical chromatogram of normal human adult oxyhemoglobin. It was obtained by reading successive tubes in a colorimeter at 580 mμ. Each of the fractions gave an absorption spectrum typical for oxyhemoglobin. Estimated total recovery is 95 percent or more. No further pigment removal was seen on washing a column with 2-percent NaOH after passage of the strongest buffer. The first fraction represents about 10 percent of the eluted oxyhemoglobin, and the second and third fractions represent about 84 percent and 6 percent, respectively.

Work with *A* (normal adult), *F* (fetal), and *S* and *C* (abnormal) hemoglobins showed entirely different chromatograms. The major fraction contained in a homozygous *S*-hemoglobin sample moves down the column more slowly than does the major fraction of normal adult hemoglobin, while fetal hemoglobin moves more rapidly than does adult hemoglobin.

The major fractions of the various hemoglobins come off the column in the following order: *F, A, S,* and *C*. This sequence is exactly the same as that reported by Prins and Huisman, using different conditions for carboxyhemoglobin. The use of oxyhemoglobin instead of carboxyhemoglobin for fractionation offers somewhat greater simplicity and, hence, less chance for denaturation of the protein.

We believe that this is the first report of a separation of undenatured normal adult hemoglobin into various fractions (*8a*). The differences in these fractions are now under investigation (*9*).

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JEAN L. COOK*
Departments of Biochemistry and *Medicine, University of Rochester School of Medicine and Dentistry, Rochester, New York*

References and Notes

1. H. K. Prins and T. H. S. Huisman, *Nature* 175, 903 (1955).
2. N. K. Boardman and S. M. Partridge, *Biochem. J. (London)* 59, 543 (1955).
3. This investigation was supported in part by a research grant H-1322 from the National Heart Institute of the National Institutes of Health, U.S. Public Health Service.
4. J. Roche, Y. Derrien, M. Roquer, *Compt. rend. soc. biol.* 146, 689 (1952).
5. J. H. P. Jonxis, in *Haemoglobin* (Interscience, New York, 1949).
6. W. N. M. Ramsay, *ibid.*
7. M. Morrison and J. Cook, *Federation Proc.* 14, 258 (1955).
8. N. J. Boardman and S. M. Partridge, *Nature* 171, 208 (1953).
8.a *Note added in proof*: After preliminary publication of our results (7) and while the present report was in press, similar findings were published by H. G. Kunkel and G. Wallenius, *Science* 122, 288 (1955).
9. We would like to acknowledge the encouragement and support of Elmer Stotz, chairman of the department of biochemistry, and of William S. McCann, chairman of the department of medicine.

* Daland Fellow of the American Philosophical Society.

5 July 1955

Radiocarbon Dates for Kara Kamar, Afghanistan, University of Pennsylvania II

Kara Kamar is a rock shelter etched by ancient water action in the face of a mountain of limestone, probably Cretaceous, and characteristic of the northern foothills of the Hindu Kush Mountains. It is situated directly above the Uzbeg village of Sar Kiar, Afghanistan, 8 miles north of Haibak, 3200 feet above sea level, and 450 feet above the plain. The shelter, which faces south, commands a view of three valleys over distances of several miles in each direction. It was excavated in 1954, as shown in Fig. 1.

Henry W. Coulter of the U.S. Geological Survey, who served as expedition geologist, is studying the soil. His preliminary results indicate the following. The entire floor was covered by a thin layer of dung. In Trench A and part of Trench B, the next layer was a deposit of powdered, chalky lime, the product of many hot fires on the limestone of the cave. It contained a mixture of flints and wheel-made pottery. Under this and extending into Trench C was found an undisturbed layer of brown cave earth overlying, in all trenches, a thick deposit of loess, which, in Trenches C and B, overlay a second and terminal layer of brown cave earth. In Trenches C and B the loess may be divided into three naturally demarcated levels on the basis of the relative fineness of the rubbly particles contained in the wind-borne material, with the coarsest on the bottom and the finest on the top. In Trench A, where it is mixed with debris from rockfall, the loess cannot be so divided with certainty, nor is the border between the upper brown earth and the loess a sharp one.

The flints and animal bones from these levels have been tentatively classified into four cultural assemblages. Culture I, found in the upper brown cave earth and in the overlying powdered lime, is typologically Mesolithic. Culture II, from the fine and medium upper half of the loess in Trenches B and C, is a flake assemblage in which the flint has turned white from weathering. Culture III, in the lower half of the medium rubbly loess and the lower loess, is an unweathered assemblage of Upper Paleolithic blade tools accompanied by horse bones. The flints in the loess of Trench A probably belong mostly to Culture III. Culture IV, in the lower brown cave earth, is a small assemblage of weathered flakes more or less similar to those of Culture

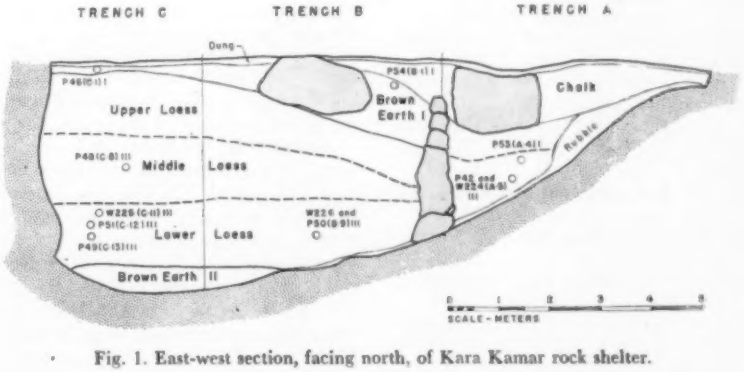

Fig. 1. East-west section, facing north, of Kara Kamar rock shelter.

Table 1. Control measurements

No.	Sample	Net counts/min
P-40	Modern young poplar from Haibak	6.40 ± 0.19
P-40a		6.34 ± 0.15
		Average 6.37 ± 0.12
P-46	C-1, culture I	6.63 ± 0.15
P-46a		6.89 ± 0.13
		Average 6.76 ± 0.10 (modern)

II and in certain respects also comparable to the numerous flint pieces collected on the surface of the slope outside the shelter.

The samples for carbon-14 dating were taken from fire-pits in the different levels and consisted of charcoal intermixed with some earth. They were all treated with hydrochloric acid to remove inorganic carbon compounds before they were processed. The samples listed in Tables 1 and 2 with prefix P were dated in our laboratory. The older ones were beyond the range of our counting method (*1*), and three of them were dated by Hans E. Suess. These three samples are listed with prefix W (*2*). With our present equipment, the maximum range is 25,000 years; the range of Suess's equipment is 32,000 years (*3*). In some cases a single sample is listed as "older than" two different dates; these are not inconsistent, but are the limits of the two different counting methods. These dates should never be quoted without the prefix "older than."

The measurements obtained with samples P-40, P-40a and P-46, P-46a (Table 1) are in agreement with previous measurements of modern carbon from other parts of the world. The ages have been calculated on the basis of a value of 6.70 ± 0.10 counts per minute for the modern net counting rate (*1*).

Table 2. Radiocarbon dates

No.	Sample	Age (yr)
P-54	B-1, culture I	2740 ± 300
P-53	A-4, typologically culture I	10,580 ± 720
P-48	C-8, top of culture III (small sample	20,000 + ∞ − 5000
P-42, P-42a	A-5, typologically culture III	Older than 25,000
W-224	A-5, typologically culture III	34,000 ± 3000
P-50, P-50a	B-9, culture III	Older than 25,000
W-226	B-9, culture III	Older than 32,000
W-225	C-11, culture III	Older than 32,000
P-51	C-12, culture III	Older than 25,000
P-49	C-13, culture III	Older than 25,000

The date of sample P-53, 10,580 ± 720 years (Table 2), probably fits culture I; culture II has no charcoal; culture III may be dated by samples W-224, W-225, and W-226 in the mid-30,000's before the present or earlier. It is worthy of note that these dates make an Upper Paleolithic blade culture, at least, contemporaneous with a Middle Paleolithic culture, that of Haua Fteah in Libya, Suess's sample W-85, which dated 34,000 ± 2800 years or possibly older (*4*).

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References

1. E. K. Ralph, *Science* **121**, 149 (1955).
2. M. Rubin and H. E. Suess, in preparation. We are grateful to Suess for dating the three of the older samples.
3. ———, *Science*, **121**, 481 (1955).
4. H. E. Suess, *ibid.* **120**, 467 (1954).

20 June 1955

Association of Molybdenum with Nitrate Reductase from Soybean Leaves

The nitrate reductases from soybean (*Glycine max.* Merr.) leaves (*1*), *Neurospora crassa* (*2*), *Escherichia coli* (*3*), and soybean nodules (*4*) are similar in many of their characteristics. All are flavoproteins that catalyze the oxidation of reduced pyridine nucleotides by nitrate to yield nitrite and oxidized coenzymes. The various nitrate reductases are similarly inhibited by KCN, NaN_3, and sulfhydryl complexing agents but have different specificities for reduced coenzymes and different *p*H optima. It has been demonstrated that the reductases from *Neurospora* (*5*) and *Escherichia coli* (*3*) are specifically activated by molybdenum. The purpose of this communication is to indicate that this metal also is associated with the nitrate reductase from soybean leaves.

An experiment was conducted to determine whether or not Mo^{99} applied to soybean seedlings was incorporated into the nitrate reductase of the leaves. Soybean seeds (variety Ogden) were germinated in flats of sand, as has been previously described (*1*). Four days after the seeds were planted the flats were treated with a sufficient amount of a solution containing 3.5 mc of Mo^{99} per gram of MoO_3 (dissolved in dilute NH_4OH and neutralized with HCl) to obtain a concentration of 10 ppm total Mo in the sand. When the seedlings were 10 days old, leaves were harvested, fractionated and assayed for nitrate reductase, as has been previously described, using DPNH as a hydrogen donor (*1*). An aliquot from each fraction was ashed in a muffle furnace and counted for radioactivity with a Geiger-Müller counter.

The nitrate reductase activities and radioactivities of the various fractions expressed on a protein basis (*6*) are reported in Table 1. The enzyme activity and radioactivity of the first two fractions were not closely correlated; however, as the purity of the enzyme increased in fractions III and IV, Mo^{99} was definitely associated with the enzyme activity of the fractions. The results of a second experiment showed the same trends as those indicated in Table 1. Further purification of the enzyme would be necessary before a constant ratio of enzyme activity to radioactivity could be expected.

In order to obtain further evidence concerning the metal requirements of this enzyme, $(NH_4)_2SO_4$ precipitates (fraction III) were prepared from fresh leaves or acetone powders of leaves, as was previously described (*1*). The enzyme samples were dialyzed for 5 hours against 0.25*M* purified phosphate buffer (*p*H 7.0) containing 0.001*M* concentrations of both glutathione and KCN, as is described by Nicholas and Nason (*5*). Afterward the samples were dialyzed for 8 hours against a similar buffer solution containing glutathione but

Table 1. Association of radio molybdenum with nitrate reductase during purification. The purification procedure was identical with that described previously (*1*), with the exception that a 0 to 50 percent $(NH_4)_2SO_4$ precipitate was obtained in fraction III instead of a 0 to 40 percent precipitate

Fraction	Protein (mg/ml)	Enzyme activity* (units†)	Radioactivity (counts/sec†)
I Crude extract	3.00	9.4	8.9
II First gel eluate	0.33	189.2	10.5
III 0 to 50 percent $(NH_4)_2SO_4$ precipitate	0.52	368.0	12.7
IIIA Supernatant from III	0.34	6.4	5.0
IV Second gel eluate	0.19	1006.6	30.0
IVA Residue after second gel adsorption	0.20	8.0	6.0

* One unit of enzyme activity is defined as the amount required to produce 1×10^{-3} μM of nitrite in 5 minutes, using the standard assay (*1*).
† Expressed per milligram of protein.

no KCN. Aliquots of the dialyzed enzyme containing 0.05 mg of protein were tested for nitrate reductase activity using DPNH in the assay (*1*) and purified buffer and KNO_3 (*7*). Other aliquots of the enzyme solution were preincubated at 2°C with 0.01 μM of various metals, and then were assayed for enzyme activity using purified reagents. The mean increases or decreases in activity in percentages from the addition of the various metal salts were: $FeSO_4$, +15; Na_2MoO_4, +47; $FeCl_3$, +15; $MnSO_4$, +4; $CuSO_4$, −43; and $ZnSO_4$, −2 for two experiments. Dialysis of the enzyme against buffers at *p*H value below 7.0 failed to remove Mo from the enzyme. These samples, however, consistently showed a small increase in activity from the addition of $FeCl_3$ or $FeSO_4$.

In view of the results reported here, it seems apparent that Mo is a constituent of the soybean leaf nitrate reductase. The results suggest that iron may partially replace Mo as a metal factor in the enzyme (*8*).

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References and Notes

1. H. J. Evans and A. Nason, *Plant Physiol.* **28**, 233 (1953).
2. A. Nason and H. J. Evans, *J. Biol. Chem.* **202**, 655 (1953).
3. D. J. D. Nicholas and A. Nason, *J. Bacteriol.* **69**, 580 (1955).
4. H. J. Evans, *Plant Physiol.* **29**, 298 (1954).
5. D. J. D. Nicholas and A. Nason, *J. Biol. Chem.* **207**, 353 (1954).
6. O. H. Lowry, N. J. Farr, R. J. Randall, *J. Biol. Chem.* **193**, 265 (1951).
7. D. J. D. Nicholas, *Analyst* **77**, 920, 629 (1952).
8. We acknowledge the valuable technical assistance of Thea Schostag. The results of the experiment indicated in Table 1 were reported in *Ann. Rept. N. Carolina Agri. Expt. Sta.* (1953).

20 June 1955

Comparative Tonographic Study of Normotensive Eyes of White and Negro Persons

Opinion is divided concerning a predilection of Negroes for glaucoma. The pertinent literature is reviewed in our extensive publication (*1*).

More pigment being present in the Negro eye, pigment granules may more readily be deposited in the trabecular meshwork, in the canal of Schlemm, and in its outlets, causing an obstacle to aqueous outflow.

The purpose of the work reported here (*2*) was to determine, with the aid of an electronic tonometer, whether there are any differences in intraocular pressure (IOP), facility of outflow (*c*), and production of aqueous humor (*K*), between

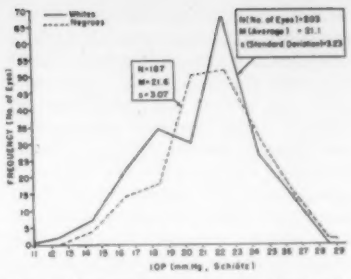

Fig. 1. Intraocular pressure distribution in 203 eyes of white persons and 187 eyes of Negro persons.

normotensive eyes of white and Negro persons. In other words, we have looked for a possible difference in the aqueous humor dynamics of Caucasians and Negroes.

One hundred seven white persons, representing a total of 203 eyes, and 97 Negro subjects (187 eyes) were studied. Of the white subjects, 52 were female (100 eyes) and 55 were male (103 eyes). Of the Negro subjects, 45 were female (86 eyes) and 52 were male (101 eyes). All persons were between 40 and 92 years of age. All eyes were free of manifest ocular disease.

It was, of course, impossible to determine the percentage of Negro blood in our subjects. We did take the precaution of selecting subjects with very dark skins, because their eyes are richer in pigment. We believe that our colored examinees are representative of the typical American Negro.

We performed tonography on each eye, using a Mueller electronic tonometer without recording attachment. The technique used was the standard one described by various authors; we followed all the precautions recently outlined by Stepanik (*3*). The values were recorded every 30 seconds; the total duration of each tonometry was 4 minutes. The facility of outflow was calculated from the formula

$$c = \frac{V_A}{(\mathrm{Av}\,P_t - P_o)t},$$

and the rate of production of aqueous humor was calculated from the formula

$$K = P_o \times c.$$

For interpretation of these formulas, the reader is referred to Grant's original papers (*4*).

All our data were evaluated statistically, using the F test of Snedecor and the t test of Student. First we compared the values of intraocular pressure, facility of outflow, and production of aqueous humor of the eyes of the white and Negro persons studied: Figures 1, 2, and 3 show the curves of distribution for intraocular pressure, facility of outflow, and production of aqueous humor, respectively, of these two groups with the relative average values (*M*) and the standard deviations (*s*). By comparing our data with the appropriate values from the F and t tables, we found that the difference between the samples was attributable to chance. In other words, no significant difference between intraocular pressure, facility of outflow, and production of aqueous humor of normotensive eyes of white and Negro persons exists.

The same statistical analysis was made on the values of intraocular pressure, facility of outflow, and production of aqueous humor for the eyes of white and Negro men and women. The calculations and the values for the F and t tests proved that all data were homogeneous for both female and male groups. Intraocular pressure, facility of outflow, and production of aqueous humor of the eyes of Negro women and men do not differ significantly from those of the eyes of white women and men.

Our investigations proved that (i) there is no significant difference between intraocular pressure of normotensive eyes of Negro and of white adults; (ii) the facility of outflow of aqueous humor is not significantly lower in the Negro eye than it is in the white eye; and (iii) the production of aqueous humor is the same in the eyes of members of both races.

Since the resistance to outflow is the reciprocal of the facility, we conclude that the eyes of Negroes do not present more resistance to outflow than do the eyes of Caucasians. The eyes of persons of the white and Negro races differ ana-

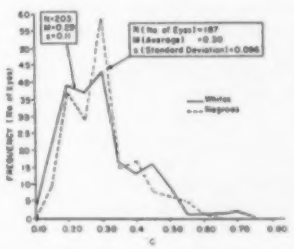

Fig. 2. Facility of outflow in the same eyes.

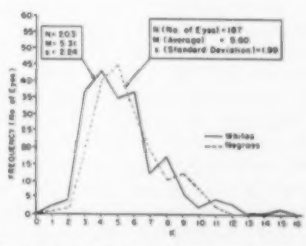

Fig. 3. Production of aqueous humor in the same eyes.

tomically, but the dynamics of the aqueous humor are equal in both. Therefore, it seems impossible to maintain the assumption that there is a predilection of Negro eyes for glaucoma.

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References and Notes

1. B. Boles-Carenini *et al.*, *Am. J. Ophthalmol.*, 40, 224 (1955).
2. Our work was aided by grant B-158 from the U.S. Public Health Service. This article was presented before the meeting of the East-Central section of the Association for Research in Ophthalmology in Buffalo, N.Y., 10 Jan. 1955.
3. J. Stepanik, *Am. J. Ophthalmol.* 38, 629 (1954).
4. W. M. Grant, *Arch. Ophthalmol. Chicago* 44, 204 (1950); 46, 113 (1951).

10 June 1955

Staining Methods in Chromatography of Acidic and Neutral Mucopolysaccharides

Staining of complex carbohydrates following separation by paper chromatography or electrophoresis requires reagents other than those commonly used for detection of simple sugars. Such reagents as potassium permanganate (*1*), ammoniacal silver nitrate (*2*), acidic naphthoresorcinol (*3*), sodium metaperiodate, and lead tetraacetate (*4*) have been used to detect nonreducing sugars. The Hotchkiss periodate method has also been employed to stain protein-bound carbohydrates on filter paper after electrophoresis (*5*), although difficulty has been encountered in the rather intense staining of the paper itself and in applying this method to the detection of acidic mucopolysaccharides after chromatography (*6*). Acidic mucopolysaccharides have also been detected after paper electrophoresis (*7*) or ascending chromatography (*8*) by virtue of a metachromatic reaction with toluidine blue.

Mucoproteins of biological origin may consist of mixtures of acidic and neutral mucopolysaccharides. Toluidine blue stains substances metachromatically with free anionic groups. Neutral mucopolysaccharides and acidic mucopolysaccharides in which the anionic groups are combined—as, for example, with proteins, or otherwise masked—stain orthochromatically (*9*) or may fail to stain at all on paper.

Mucicarmine is frequently used empirically in staining procedures for the demonstration of "mucin" from various epithelial secretions (*10*). This stain may be effective histologically in sites where toluidine blue fails to stain (*11*). The chemical basis for its staining action is uncertain (*12*).

Mucicarmine has been adopted by us as a stain for locating the position of acidic and neutral mucopolysaccharides following paper partition chromatography. Heparin, potassium chondroitin sulfate from cartilage (*13*), and potassium hyaluronate from umbilical cord (*13*) served as acidic mucopolysaccharides. For a neutral mucopolysaccharide, dialyzed and concentrated blood group substances A and B (Sharp and Dohme) from hog and horse stomach were used. The product was subjected to hydrolysis with $2N$ H_2SO_4, and chromatographic examination for simple sugars revealed fucose, galactose, and hexosamine. Hexuronic acid was not detected on the chromatograms. Only traces of hexuronic acid could be detected by use of the naphthoresorcinol method (*14*).

Duplicate ascending chromatograms of solutions of blood group substances and acidic mucopolysaccharides were run on Whatman No. 1 paper for 22 hours at 23°C. The solvents found most satisfactory consisted of 55 percent of $0.05M$ Na_2HPO_4 and 45 percent of redistilled isopropyl alcohol, and 58 percent of a phosphate-sodium chloride buffer ($0.0007M$ NaH_2PO_4, $0.09M$ Na_2HPO_4, and $0.07M$ NaCl) (*15*) and 42 percent of redistilled isopropyl alcohol.

After the chromatograms have dried, fixation of the paper is desirable before staining. This was suggested by Leitner and Kerby (*6*) who used 95-percent alcohol and ether for this purpose. We have obtained somewhat sharper delineation of spots and more brilliant colors after staining by using formalin and ethanol as a fixative. Each chromatogram was immersed in a mixture of 20 ml of neutral formalin and 80 ml of absolute ethanol for 15 minutes. After drying, one chromatogram was sprayed with toluidine blue, the other with mucicarmine. Both sides of the paper were sprayed and care was taken to avoid running of the dye on the paper.

Recent reports have described many fractions in commercial toluidine blue of varying staining ability (*16*). In addition to a metachromatic staining fraction, much of the dye lot may either stain chromotropes orthochromatically or lack staining power entirely. Hence, commercial toluidine blue was recrystallized several times from hot water and alcohol before use. Forty milligrams of the recrystallized dye was added to 80 ml of acetone and 20 ml of distilled water. The solution was stored in a dark bottle at 5°C. Acetone effectively prevented spreading of the spots and did not inhibit metachromasy as alcohol does at this concentration. Other cationic dyes (pinacyanol, methylene blue, and crystal violet) were tried, but toluidine blue was the most satisfactory in brilliance of metachromatic color and in showing the least background discoloration of the paper.

Mucicarmine stock solution was prepared according to Lillie's method (*17*). The carmine was not recrystallized. Different dye batches gave similar staining results. One gram of carmine, 0.5 g of anhydrous $AlCl_3$, and 2 ml of distilled water were heated together in a porcelain crucible for 2 to 3 minutes. It was found desirable to drop the crucible directly into 100 ml of 50-percent ethanol. After 24 hours the solution was filtered and stored at 5°C. The spraying reagent was made up prior to use. Five milliliters of the stock solution were added to 17 ml of absolute ethanol and 3 ml of distilled water.

After the chromatograms had been sprayed, they were repeatedly rinsed in distilled water acidified with a small amount of glacial acetic acid (*6*) until the background discoloration was largely removed; then they were washed in distilled water and hung up to dry. More vivid metachromatic color changes were noted on chromatograms that had been sprayed with toluidine blue when they were dried in the cold.

Toluidine blue revealed acidic mucopolysaccharides as bright pink (heparin) or purple (chondroitin sulfate and hyaluronate) spots on a light blue background. Blood group substances did not stain. Mucicarmine stained both acidic mucopolysaccharides and blood group substance bright pink on a very light pink or colorless background.

The use of these two sprays on duplicate chromatograms thus permits the separate identification of acidic and neutral mucopolysaccharides in materials of biological origin (*18*).

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References and Notes

1. E. Pascu, T. P. Mora, P. W. Kent, *Science* 110, 446 (1949).
2. L. Hough, *Nature* 165, 400 (1950).
3. S. M. Partridge, *Biochem. J.* 42, 238 (1948).
4. J. G. Buchanan, C. A. Dekker, A. G. Long, *J. Chem. Soc.* 1950, 3162 (1950).
5. E. Kiow and A. Gronwall, *Scand. J. Clin. and Lab. Invest.* 4, 244 (1952).
6. J. G. Leitner and G. P. Kerby, *Stain Technol.* 29, 257 (1954).
7. K. G. Rienitz, *Biochem. J.* 53, 79 (1953).
8. G. P. Kerby, *J. Clin. Invest.* 33, 1168 (1954).
9. D. Hamerman and M. Schubert, *J. Gen. Physiol.* 37, 291 (1953).
10. F. B. Mallory, *Pathological Technique* (Saunders, Philadelphia, 1938).
11. G. Gomori, *Brit. J. Exptl. Pathol.* 35, 377 (1954).
12. J. F. A. McManus, Ed., *Progress in Fundamental Medicine* (Lea and Febiger, Philadelphia, 1952).
13. These samples were generously supplied by Maxwell Schubert, New York University College of Medicine.
14. Corn Products Sales Co. Technical Bull., Y24-200.

15. D. H. Moore, in instruction manual for Tiselius electrophoresis apparatus, Perkin-Elmer Co. (1951).
16. J. Ball and D. S. Jackson, *Stain Technol.* **28**, 33 (1953); B. H. Persson, *Acta Soc. Med. Upsaliensis* **58**, Suppl. 2 (1953); M. DiBeradino, *Stain Technol.* **29**, 253 (1954).
17. R. D. Lillie, *Histopathologic Technique* (Blakiston, Philadelphia, 1948), p. 150.
18. The opinions expressed in this paper are those of the author and do not necessarily represent those of any governmental agency.

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2 February 1955

Technique for Assessing the Effects of Drugs on Timing Behavior

Before a drug can safely be recommended for relief of a specific physiological malfunction it must be checked for possible deleterious effects upon other systems. Careful consideration must also be given to the possibility of "toxic" effects upon normal adaptive behavior, particularly in the case of those drugs that are known to produce behavioral changes. In view of the importance of temporal orientation in normal behavioral functions, the effect of drugs upon timing would appear to constitute a primary area of investigation. The purpose of this report is to describe a method, based on earlier work by Skinner (*1*), for producing and measuring timing behavior in experimental animals, and to present some data resulting from the administration of amphetamine and alcohol (*2*).

White rats, deprived of water for 22.5 hours, were placed in a small chamber containing a lever and a mechanism for automatic delivery of a small drop of water. In the first session every depression of the lever by the animal produced the water reinforcement. In all following sessions, each 2 hours long, reinforcement was contingent on lever presses spaced at least 21 seconds apart. That is, a response produced the water only if it followed the preceding lever depression by at least 21 seconds. Programming and recording were accomplished automatically by timers, magnetic counters, and associated relay circuits.

Using this procedure, Wilson and Keller have demonstrated that the rate of lever pressing is inversely related to the length of the required delay between responses (*3*). Since drug-produced general excitatory or depressive effects might themselves alter the rate of lever pressing (*4*), a more useful measurement of the timing is the relative frequency distribution of interresponse times (intervals between successive responses). This distribution, which displays no consistent trend after the animals have been exposed to the experimental procedure for 30 to 60 hours, is illustrated by the "saline" control records of Fig. 1. The large proportion of responses that are spaced less than 3 seconds apart is typical and unexplained, but the remainder of the distribution provides a clear description of the timing behavior. The relative frequencies of interresponse times rise to a peak between 18 and 21 seconds and then display a gradual decline.

The center sections of Fig. 1 illustrate the effects of two relatively large doses of *dl*-amphetamine sulfate administered subcutaneously, 5 minutes prior to the experimental session, in a solution of 1 mg/ml of physiological saline. Increasing doses of this drug tend to move the peak of the distribution progressively toward the short interresponse times. That is, the animals press the lever more frequently before the required interval has elapsed.

In addition to the shifts in the relative frequency distribution, large increases in the total response output occurred (Table 1). In contrast, intraperitoneal injection of 3 ml of a 10-percent ethyl alcohol solution, representing a dose of 1 mg/kg, produced a decline of more than 50 percent in the rate of lever pressing. The relative interresponse time frequencies, however, as shown in the lower section of Fig. 1, displayed little change except for a slight leveling of the total distribution. Although alcohol, in the dose administered, produced a general depression of lever-pressing behavior, there was relatively little effect upon the timing.

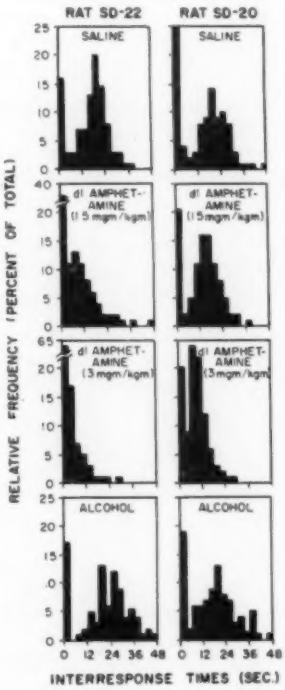

Fig. 1. Relative frequency distributions of the time intervals between successive lever presses. Each distribution represents one animal's performance in a single 2-hour session.

Table 1. Total number of lever presses emitted during each 2-hour session

Rat	Saline	*dl*-Amphetamine		Alcohol
		1.5 mg/kg	3.0 mg/kg	
SD-20	471	534	854	201
SD-22	433	820	1816	176

This technique for generating and measuring timing behavior is applicable to the minimally restrained individual organism, produces stable behavior over long periods of time, has procedural simplicity, and permits automatic programming and recording. The orderly response to drugs, illustrated by this data, indicates the feasibility of including this method in programs designed to screen drugs for their behavioral effects.

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References and Notes

1. B. F. Skinner, *The Behavior of Organisms* (Appleton-Century, New York, 1938), p. 306.
2. I gratefully acknowledge the technical assistance of Irving Geller and George Sasla in the conduct of these experiments.
3. M. P. Wilson and F. S. Keller, *J. Comp. Physiol. Psychol.* **46**, 190 (1953).
4. B. F. Skinner and W. T. Heron, *Psychol. Rec.* **1**, 340 (1937).

13 June 1955

Altering Juvenility with Auxin

One of the most carefully described instances of the juvenile phase in plant development is that of the Brussels sprouts (*Brassica oleracea gemmifera* L. var. Kolom) (*1*, *2*). Plants of this species must reach a certain age—generally 11 weeks—before they are sensitive to the floral inductive experience of low temperature.

The effectiveness of low temperatures on flowering is known for many species of plants (*2*–*5*). The recent report by Moore (*6*) that auxin applied before low temperature may accentuate the bolting response of cabbage suggests the possibility that auxin levels insufficient for bolting may be a partial basis for juvenility.

This paper (*7*) deals with the influence of auxin on the low temperature induction of floral initiation in Brussels sprouts. It is shown that an application of auxin during the cold treatment has a promotive effect on flowering and can effectively shorten the juvenile phase.

Table 1. Influence of auxin on flowering of Brussels sprouts when applied to plants of various ages. Ages at the beginning of cold treatment are given.

Age (wk)	Plants flowering (%)					
	Auxin before induction (ppm)		Auxin during induction (ppm)		Auxin after induction (ppm)	
	0	50	0	50	0	50
15	100	100	100	100	100	100
13	100	100	100	100	100	80
11	70	70	60	80	80	40
9	0	0	0	60	10	0
7	0	0	0	0	0	0
5	0	0	0	0	0	0

Six groups of plants of different ages, respectively 5, 7, 9, 11, 13, and 15 weeks old, were simultaneously given a cold treatment (5°C) of 9 weeks duration. To each group, auxin (0, 50, or 500 parts per million naphthaleneacetic acid in lanolin) was applied over a period of 10 days either before, during, or after the cold treatment to the debladed petiole stumps of the 2 youngest mature leaves. Each treatment was given to 10 plants. The plants were grown during the whole experiment (September 1954 to April 1955) in the greenhouse.

The percentages of plants that flowered in response to the cold treatment are given in Table 1. Just as expected, control plants younger than 11 weeks at the commencement of cold treatment did not flower except for one plant in the third series, which flowered at 9 weeks of age. However, plants 9 weeks of age treated with 50 parts per million of auxin during the cold treatment flowered in 60 percent of the cases. The auxin applications before or after the cold treatments were essentially ineffective in shortening the juvenile phase.

It is interesting to note that Stokes and Verkerk (*1*) have reported that earliest flowering occurs in this species at about the thirtieth node. Our data agree in that the average node of first flower of the 11-week-old plants was 31.8. However, the induced 9-week-old plants flowered at 19.3 nodes.

Not only did auxin paste treatment bring about flowering of apparently juvenile plants, and at a node lower than normal, but the 50-parts-per-million treatment also hastened floral initiation *in time* when it was applied during the cold treatment. The effects on time of flowering are shown in Fig. 1. Auxin applied during the cold treatment hastened the appearance of flower buds by 3 to 4 days. There was little effect resulting from treatment before the cold, and no effect with the aftertreatment. The effect of the high auxin application (500 parts per million) was much less pronounced. The question arises whether a lower concentration than the ones that were used would be still more effective.

The lengths of flower stalks yielded an interestingly similar response, as shown in Table 2. It can be seen that stalk elongation was increased by auxin applied during the cold induction. This increase ranged from 16 to 52 percent. Auxin applied before or after the induction had no apparent effect on length of flower stalks.

The data presented here indicate that under the test circumstances, auxin applications during cold treatment can permit floral initiation of otherwise juvenile plants of Brussels sprouts, at an unusually low node, with an acceleration evident both in the 9- and 11-week-old plants, and with a resultant increase in length of the flower stalks as well.

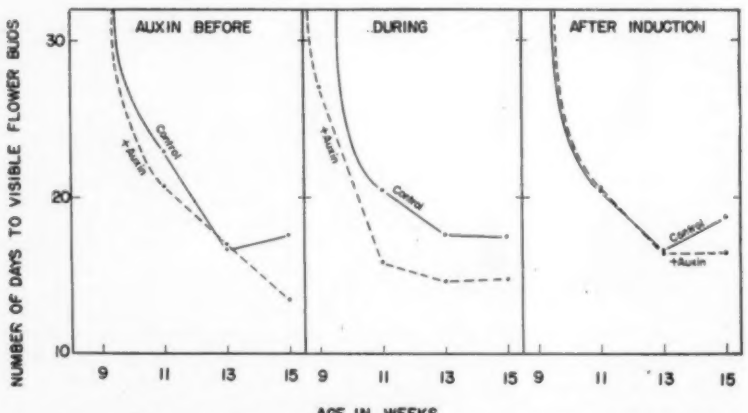

Fig. 1. Effects of auxin (50 parts per million naphthaleneacetic acid) applied at various times upon the time of flowering of Brussels sprouts plants.

Table 2. Influence of auxin applied during induction on the length of the flower stalk of Brussels sprouts. Ages of plants at the beginning of cold treatment are given.

Age (wk)	Length of flower stalk (cm)		
	Auxin concentration (ppm)		
	0	50	500
15	46.0	51.5	40.0
13	34.6	50.2	43.0
11	26.0	34.3	26.6
9		5.2	4.7
7			
5			

The results of these experiments extend the growing body of evidence that auxin treatments associated with low temperatures are promotive of flowering. Previous studies have reported such auxin promotions for species sensitive to photoperiods, to vernalization, and for indeterminant species (*8*). In the present experiments, auxin treatment resulted in flowering of otherwise juvenile plants. It is suggestive that the completion of the juvenile phase may be in part the accumulation of a sufficient auxin level at the apical meristem to bring about the condition receptive to cold.

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References and Notes

1. P. Stokes and K. Verkerk, *Mededel. Landbouwhogeschool Wageningen* 50, 141 (1951).
2. K. Verkerk, *Koninkl. Ned. Akad. Wetenschap. Proc.* C57, 339 (1954).
3. A. M. Hartsema, G. Luyten, H. Blaauw, *ibid.* 27, 1 (1930).
4. A. C. Thompson, in *Growth and Differentiation in Plants*, Ed. W. E. Loomis (Iowa State College Press, Ames, 1953).
5. H. F. Waterschoot, *Koninkl. Ned. Akad. Wetenschap. Proc.* 31, 1 (1927).
6. E. L. Moore, Ph.D. thesis, Michigan State College, 1954.
7. Journal paper No. 872, Agricultural Experiment Station, Lafayette, Ind. This work was supported in part by a grant from the Foreign Operations Administration.
8. A. C. Leopold and F. S. Guernsey, *Am. J. Botany* 40, 46 (1953); *Science* 118, 215 (1953); *Am. J. Botany* 41, 181 (1954).

9 July 1955

Production of Toxin by Resting Cells of Cl. Parabotulinum Type A

The toxin of *Cl. parabotulinum* type A is a high molecular (*1*) protein distinguished by its extremely high biological potency (*2*). It appeared therefore that this system might provide an interesting model for a study of protein biosynthesis. Toxin formation by these cells is a rela-

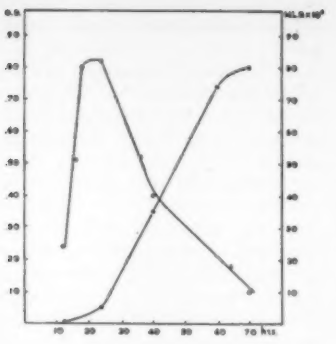

Fig. 1. Growth and toxin production by *Cl. parabotulinum* type A. ● —— ● Toxin titer (MLD × 10^4/ml); ○ —— ○ optical density (outside diameter) at 500 mμ, measured in the Coleman Junior Spectrophotometer.

tively rapid process, lending itself to a kinetic approach.

The growth curve of *Cl. parabotulinum* in a suitable medium is characterized by a sharp peak (between 18 and 24 hours), followed by rapid decline owing to autolysis. During the logarithmic phase little toxin is found in the medium. On continued incubation, the toxin titer increases steeply and reaches a maximum at the completion of lysis (Fig. 1). This curve suggested the possibility that the toxin is formed intracellularly and is released into the medium, upon autolysis.

In order to test this hypothesis and to determine the essential factors governing toxin production in the absence of growth of the organism, the technique of resting cells was employed.

Cl. parabotulinum type A (strain 2) was grown in a semisynthetic medium (*3*). After incubation for 18 hours, the cells were collected by centrifugation and were washed with saline containing 0.05 percent thioglycolate or with fresh medium as desired. The cells were then taken up in a small amount of thioglycolate-saline and added to the reaction mixture; the final cell concentration, as measured by optical density, was 3 to 4 times higher than that of the original culture. Incubation was carried out at 34°C in evacuated jars; subsequent experiments under aerobic conditions gave the same results.

At the start of the experiment and after incubation for 24 hours, the titer of the toxin was determined by intraperitoneal injection into mice, using the MLD procedure (*4*). As is shown in Table 1, the omission of either salt solution B, vitamins, or nonessential amino acids from the complete medium did not affect appreciably toxin formation. On the other hand, the absence of glucose, phosphates (salt solution A), or even one of the amino acids essential for growth, for example, tryptophan (*3*), resulted in a drastic reduction of the toxin yield. The fact that glucose is required for toxin production but not for growth suggests that a rich source of energy is necessary for the synthesis of the toxin.

The observation that certain nutrilites are required, both for growth and for toxin production, made it necessary to prove more stringently that under the conditions employed the formation of the toxic protein took place in the absence of cell multiplication. Such a proof was provided by the finding that penicillin (1000 to 10,000 units/ml) and α,α-dipyridyl (50 μg/ml) did not affect toxin production at all, whereas they suppressed growth completely even at lower concentrations (1 unit/ml or 20 μg/ml, respectively) (Table 1).

Before measurable lysis took place, only small amounts of toxin (20,000 to 100,000 MLD/ml) could be demonstrated in the cell suspensions. When, however, lysis was induced artificially by sonic oscillations (exposure for 15 minutes to vibrations in the 9KC Raytheon oscillator), large quantities of toxin were released into the medium. These experiments provide, therefore, direct evidence for the intracellular synthesis of the botulinus toxin. In addition it must be concluded that the toxin present *within* the cell is not detectable by the *in vivo* test employed.

Table 1. Toxin production by nonproliferating cells (thick suspensions) of *Cl. parabotulinum* type A

Omissions from complete medium*	MLD/ml
None	2,500,000
Vitamins	2,500,000
Amino acids	100,000
9 nonessential amino acids	2,200,000
Tryptophan	150,000
Glucose	200,000
Salts A (phosphates)	300,000
Salts B ($NaCl$, $MgSO_4$, $MnCl_2$, $FeSO_4$)	1,750,000
None; addition of penicillin (1000 units/ml)	2,500,000
None; addition of α α-dipyridyl (50 μg/ml)	2,000,000

* Complete culture medium: synthetic medium as described previously (*3*). Toxin titer at zero time: 10,000 MLD/ml. Incubation period: 24 hours at 34°C.

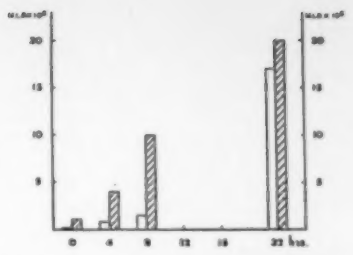

Fig. 2. Rate of toxin formation (free and total) by resting cells of *Cl. parabotulinum* type A. Unshaded bars, free toxin; shaded bars, total toxin (obtained by sonic treatment). Resting cells of *Cl. parabotulinum* type A, suspended in complete medium (see Table 1) and incubated at 34°C.

By using the sonic treatment, the amounts of toxin formed intracellularly after various periods of time could be determined. The results as illustrated in Fig. 2 appear to warrant the following conclusions: (i) Comparatively small amounts of toxin are produced by growing cells up to the end of the logarithmic phase (50,000 to 100,000 MLD/ml as assayed after release of the toxin by sonic disruption). (ii) Resting cells (in a medium containing the necessary ingredients produce toxin at a very rapid rate; an eightfold increase is reached within 4 hours, thus giving about 40 percent of the total amount formed after 24 hours.

The procedure described offers a convenient system for a study of the biosynthesis of the botulinus toxin in the absence of cell multiplication.

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References and Notes

1. G. Kegeles, *J. Am. Chem. Soc.* **68**, 1670 (1946); F. H. Putnam, C. Lamanna, D. G. Sharp, *J. Biol. Chem.* **165**, 735 (1946).
2. W. E. Van Heyningen, *Bacterial Toxins* (Blackwell, Oxford, England, 1950).
3. J. Mager, S. H. Kindler, N. Grossowicz, *J. Gen. Microbiol.* **10**, 130 (1954).
4. MLD represents minimal lethal dose.
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17 June 1955

Important principles may and must be flexible.—ABRAHAM LINCOLN.

Book Reviews

Man in a Cold Environment. Physiological and pathological effects of exposure to low temperatures. Alan C. Burton and Otto G. Edholm. Edward Arnold, London; Williams and Wilkins, Baltimore, 1955. xiv + 273 pp. Illus. $6.75.

In bringing together the material on the influence of cold on man from government World War II reports and the open literature, the authors have done a great service to physiologists interested in human responses to low temperature. When to this practical service there is added the particular viewpoints of investigators who have contributed much to the field, there results a book of importance.

The book is centered about the discussions of three topics: the physics and physiology of maintaining the thermal steady state during exposure to low temperature, the vascular and metabolic responses of animals and man to prolonged exposure to cold (including acclimatization and adaptation), and the noxious effects of cooling tissues below the physiological range of temperatures. The first of these topics is treated in a way that can be easily understood even by the "busy executive," but for those working in the field of cold physiology it will seem that this discussion is much oversimplified. The problem of temperature regulation in the cold receives little attention, and perhaps for this reason the discussion of the primary response to cold, the sensation of cold itself, is omitted. However, the treatment of the insulation afforded by clothing and by the peripheral tissues of the body is excellent.

The chapters on the vascular and metabolic responses are also satisfying and contain a full discussion of the important experiments of Burton and Brank on the muscle action potentials of cats exposed to cold but prior to shivering. The evidence in animals with respect to the existence of "chemical regulation" of body temperature and acclimatization to cold is well reviewed. The difficulty of obtaining good data on these topics from studies on man is noted and the hope expressed that someday experiments will be carried out on the Tierra del Fuegan aborigines. The topics of hypothermia and cold injury are discussed briefly but well, with comments on the large areas in which present-day knowledge is deficient.

The book is an excellent review of the present state of knowledge on the topics that the authors have felt have not previously been covered, and for this reason physiologists will need the volume for reference. On the other hand, the book is so well written that it can be enjoyed by all who are interested in the many peculiar effects of cold on man.

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Symposium on Problems of Gerontology. Nutrition Symposium series, No. 9. Robert S. Goodhart, Ed. National Vitamin Foundation, New York, 1954. ii + 141 pp. Illus. Paper, $2.50.

In his foreword the editor points out that in the first half of the 20th century there have been remarkable advances in the reduction of mortality in infancy and childhood from infectious diseases and that we are confronted now with problems in promoting the welfare of approximately 13 million people of 65 years and over. He rightly says that knowledge and understanding of the metabolic changes, both normal and abnormal, associated with ageing are essential.

During the reading of this publication several points impressed me. The 10 participants could not have been better selected. They are N. W. Shock (Baltimore), A. I. Lansing (St. Louis), H. J. Deuel, Jr. (Los Angeles), C. S. Davidson (Boston), B. F. Chow (Baltimore), J. E. Kirk (St. Louis), F. H. Bethell (Ann Arbor), C. N. H. Long (New Haven), D. J. Ingle (Chicago), and H. A. Rafsky (New York). Each is to be congratulated on the clarity of his presentation and on the fact that it is definitely focused on ageing from the point of view of metabolism. It is a relief to find that this can be done effectively without resort to complicated formulas and advanced mathematics. All presentations are accompanied by short but well-chosen lists of references to the literature for purposes of follow-up.

In this volume the reader will find a good presentation of the essential biological background. Many significant experiments with lower animals afford clues to conditions in man and to rewarding investigations that should be carried on. Well-established data on the dietary needs and metabolic handicaps of older persons as compared with younger ones are made available. It is pointed out that the usual yardstick of adequate nutrition employed for young adults does not necessarily apply to elderly subjects. Alterations in the absorption of fat and in the roles of sex hormones are emphasized. There is little evidence to think that pituitary function fails in old age. Indeed, the secretion of gonadotropic hormones increases as gonadal function falls off. The perils of overeating are underscored. Experimental obesity in rats resulting from small lesions produced in the hypothalamus is discussed. There is much discussion about vitamin B_{12} and its distribution in the body when it is labeled with Co^{60}. The strains that older people undergo are viewed in terms of Selye's work. It is said "that Selye's concept of the role of endocrine response to nonspecific stressors in causing disease is one of the most important ever raised in medicine." Stress is defined "as a harmful state of disturbed homeostasis."

If there is anything that would add to the symposium as published, it would be inclusion of questions by the group and answers to them by the symposium participants.

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Gas Dynamics of Cosmic Clouds. A symposium of the International Union of Theoretical and Applied Mechanics and International Astronomical Union. Interscience, New York; North-Holland, Amsterdam, 1955. xii + 247 pp. Illus. + plates. $5.75.

This volume, the second in the symposium series of the International Astronomical Union, gives the proceedings of a symposium held at Cambridge, England, in July 1953. This symposium was organized jointly by the IAU and by the IUTAM (International Union of Theoretical and Applied Mechanics). It received a grant-in-aid of $6000 from UNESCO to cover traveling expenses of scientists attending this symposium, and UNESCO also assisted with the publishing of the proceedings.

The symposium was the second one on cosmical gas dynamics, the first one having been held at Paris in August 1949. Of the 63 participants from nine countries (35 from outside the U.K.), 41 were astronomers or astrophysicists and 22 were aerodynamicists or physicists. Altogether 37 papers were given in eight sections dealing with the following main topics: observational data, physical conditions of the interstellar gas, shock waves and collision problems, turbulence and magnetic fields in a compressible gas, formation of cosmic clouds and galaxies, accretion problems, and gas and dust in the interstellar medium.

From the papers it can be seen that a huge amount of work has been done between the two symposia, and some problems are beginning to look more tractable. The emphasis has shifted to a large extent to a discussion of shock waves in astrophysics. Unfortunately while most aerodynamical research is concerned with relatively small Mach numbers, in astrophysics one is dealing with large Mach numbers, and it seems unlikely that the results from aerodynamics can be applied to astrophysical problems. Another problem that is again very open is that of the origin of galactic magnetic fields, while the old problem of the distribution of angular momentum among cosmic bodies remains as far as ever from a solution.

Since this book contains the text of the discussions and papers delivered at a symposium, relatively few detailed and quantitative calculations are given, but from the discussion one can obtain an impression of the activities going on in this modern branch of astrophysics, and the volume should be very stimulating to astrophysics research workers who were not at the conference, just as the symposium itself must have stimulated those who were fortunate enough to be present.

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Einführung in die Energetik und Kinetik biologischer Vorgänge. W. Bladergroen. Wepf, Basel, 1955. ix + 368 pp. Illus. F. 28.

Discussions of the energy changes and kinetics in biological systems have formed parts of several excellent works in recent years written on the subjects of proteins, enzymes, and metabolic processes in the organism. A number of these works reviewed, in their respective chapters, the physical and physiochemical methods that concern every research worker engaged in problems of enzyme mechanism and enzyme kinetics.

Important as these reference books are for the researchers in the immediate field, too few works are available for the use of scientists in fields closely related to the afore-mentioned subjects. Workers in biology and medicine who are not directly dealing with problems of enzyme kinetics, for example, nevertheless need the general knowledge and approach of this rapidly expanding field.

This is one of the reasons that Bladergroen's concise book closes a gap. It is both an easily readable and a useful book for those who, while lacking the time to examine the problems in detail, nevertheless want to acquaint themselves with such topics as oxidation and reduction without having to equip themselves with the full mathematical knowledge of thermodynamics.

To be concise and still include all the necessary material is a problem that authors face eternally, and Bladergroen's book is no exception. To illustrate the working of physical laws in biological systems with numerous examples cannot be recommended enough in this type of treatise. The very ardor of the author to do so might lead, however, to the inclusion of too many such examples, which then cannot be explained in the necessary detail. To illustrate the role of the phosphate bond in biological systems, Bladergroen adequately employs such examples as acetylation, carboxylphosphates, and ATP and its role in muscle contraction and choline acetylation. The citric acid cycle is included too, and the half-page of text devoted to it can hardly explain it to those who do not already know more than is described there. To cover all sides of the problems in an introductory book is hardly possible, and perhaps fewer examples in greater detail would serve the purpose equally well. It should be mentioned here that the numerous and well-chosen references at the end of the individual chapters facilitate the gaining of further information for those interested in following up the presented material.

Bladergroen takes special care to use only the most necessary equations for ease of understanding without sacrificing clearness or usefulness. In this task he succeeds remarkably well. Of the 17 chapters in the book, the first five are concerned with the thermodynamic principles and relate them to practical problems in biological systems. Five other chapters deal with enzymes (in general terms) and coenzymes and catalysis with respect to kinetics and energy changes. Inhibition, activation, enzyme-substrate binding, and temperature and *p*H effects are briefly and clearly summarized in these chapters. One chapter on the principles of kinetics includes such subjects as bimolecular reactions and energy of activation. A theoretical chapter examines the possible implications of quantum physics in biology. Other chapters discuss photosynthesis and energy relationships in metabolism; one mentioned in a preceding paragraph deals with the phosphate bond; and, on the practical side, there is a chapter on energy in nutrition. The book is a useful compendium for students and research workers alike.

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Materials for Nuclear Power Reactors. Henry H. Hausner and Stanley B. Roboff. Reinhold, New York, 1955. 224 pp. Illus. $3.50.

In his historic report, *Atomic Energy for Military Purposes,* H. D. Smyth commented on the troubles encountered in sheathing or canning the uranium rods for the Hanford reactors. He said, "Strangely enough, this 'canning problem' turned out to be one of the most difficult problems encountered in such piles." Today, a decade later, it is still true that the major obstacle to successful nuclear reactor design is the choice of materials and methods of construction. It must be admitted that the character of the problem has changed. Whereas the Hanford reactors operated at low temperature and produced but little power in unit volume, the current trend is toward ever higher temperature and greater specific power. As a result, the materials problems have become more varied and more difficult to solve, and aid is badly needed.

This book by Hausner and Roboff is the first unclassified one that is devoted entirely to materials for power reactors, but unfortunately it will be of little help to hard-pressed reactor designers. The authors offer it as a guide for two very diverse kinds of readers: scientists and materials engineers in one group, and investors, insurance men, lawyers, executives, and students in the other. Clearly, it is not possible to serve both groups adequately, and the book appears to be slanted toward the latter. It is a highly readable pocket-size primer that devotes considerable space to an elementary explanation of the fission process, reactor types, and radiation hazards and the remainder (equivalent to about 50 full-sized pages) to its main subject of construction materials. The general nature of the problems is outlined, as well as possible methods of approach to their solution. Quantitative data are meager and there are notable gaps. Some of this dearth of detailed information is undoubtedly attributable to security restric-

tions, but the Atomic Energy Commission has declassified a wealth of useful information; perhaps a more comprehensive bibliography would have been helpful.

The book is timely and should be of interest to newcomers to reactor design and to others who want a broad and general survey of the subject.

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Practical Medical Mycology. Edmund L. Keeney. Thomas, Springfield, Ill., 1955. 145 pp. Illus. $4.50.

The publishers do themselves little credit by decorating the jacket of this small volume with claims for an extensive coverage of the field of medical mycology. Keeney's book is essentially a handbook of the pathology and therapy of mycotic infections. As such, it should be useful to the clinician concerned with the treatment of diseases of fungal origin. For the mycologist or microbiologist interested in fungi of medical importance, it contains very little information.

Fourteen of the 16 chapters comprising *Practical Medical Mycology* contain charts describing the life-history, course of infection, related clinical findings, and something of the morphology and cultural characteristics of the fungus that causes the mycosis under discussion. The supporting texts give brief statements about the taxonomy of each fungus, a terse history of the recognition of its role in the etiology of the disease, and somewhat detailed considerations of the pathology and the treatment of the infection. Those portions devoted to treatment are compact, and their documentation accounts for the majority of recent references to be found in the bibliography of the book.

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Geography of the Northlands. George H. T. Kimble and Dorothy Good, Eds. Wiley, New York; Chapman & Hall, London, 1955. x + 534 pp. Illus. $10.50.

More than 25 years ago, The American Geographical Society of New York made a notable contribution to knowledge of the Arctic and Antarctic by publishing *The Geography of the Polar Regions* as No. 8 in its series of Special Publications. The volume reviewed here is No. 32 in that series and so, in a sense, provides an up-to-date compendium of the kinds of information that made the earlier volume so generally useful.

During the past quarter-century interest in the northern lands has increased enormously, and there is now a demand for accurate geographic information about them far beyond the comparatively limited circle familiar with the 1928 publication. For example, there are many colleges and universities offering courses in arctic subjects, and the military services include them in training programs. For these reasons *Geography of the Northlands* is apparently designed as a textbook for the college course, while also serving as a reference volume.

The list of contributors is impressive, most of them being associated in one way or another with McGill University, Montreal, or the Arctic Institute.

Following an editorial introduction, the 27 chapters fall into two groups—"Systematic studies" and "Regional studies." The former covers the arctic and subarctic region topic by topic, from physiography to politics and strategy. The chapters on the natural sciences are, in my opinion, more authoritative than those on the social sciences. The chapters on population and resources are particularly weak and betray the lack of geographical training of the authors.

Among the regional studies, several are outstanding, particularly those by J. Brian Bird on "Eastern Canada" and "Iceland" and that by Svenn Orvig on "Svalbard." The chapter on "Greenland" is woefully inadequate, and much of it is, in fact, invalidated by part of an earlier chapter on "The wealth of the northlands." Six chapters on as many regions of the Soviet Union by Bogdan Zaborski are an admirable contribution to our all too sparse knowledge of this extensive part of the northland.

From internal evidence, it appears that some parts of the volume were prepared several years before publication, and a number of maps have been made obsolete by the passage of time. A noteworthy example is a map of weather stations in the northlands, used to illustrate the concluding chapter. Although it is undated, it appears to have been prepared 7 or 8 years ago, before some of the far northern stations in Canada existed.

Despite the apparent long delays in publication, there are, nevertheless, a number of cases of editorial oversight, the most striking of them being the use of a photograph of a corner of a defunct marble quarry in northwest Greenland over a caption referring to the well-known cryolite mine at Ivigtut.

Geography of the Northlands is the only book available that covers comprehensively an area of rapidly increasing significance. If only for this reason, it deserves wide distribution, despite its rather high price. The editors should, however, take the earliest opportunity to reinforce the weaker chapters and to bring the whole of the text up to date.

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The Colloid Chemistry of Silica and Silicates. Ralph K. Iler. Cornell Univ. Press, Ithaca, N. Y., 1955. xii + 324 pp. Illus. $5.50.

The title of this book might seem restrictive at first glance, but one must recall that, although colloid chemistry is merely one branch of physical chemistry, it is a complex one. Furthermore, as the nine chapter headings suggest, the subjects discussed overlap or extend into other fundamental areas, such as biochemistry and plant physiology, with respect to the last chapter, and structural crystallography and the mineralogy of clays with respect to Chapter VII. Other chapters discuss the silica-water system, soluble silicates, silicic acids, their esters, colloidal silica, amorphous silica gels, and surface chemistry. Both author and subject indexes are included.

"Colloidal Silicates," Chapter VII, is a major one. Here an attempt is made to summarize much of what is known about silicate minerals, chiefly the clay minerals, without reference to many original works. In discussing the crystal chemistry and structure of montmorillonite, for example, the hypotheses of Hofmann, Endell, and Wilm, of Edelman and Favejee, and of McConnell are not mentioned directly. Several structural diagrams are taken from F. H. Norton's *Elements of Ceramics*, a book that suffers from similar deficiencies in the evaluation of recent mineralogic and crystallographic concepts. A minor blemish is the misspelling of Norrish's name.

This series of the Baker lectures, under the auspices of Cornell University, surely must have been a real stimulus to those who heard the lectures, if one can judge by the provocative information contained in the printed record. Brief, but frequent, mention of the practical application adds interest and gives the book a readability that is not often obtained in works of this type.

Iler has gone far beyond the conventional approaches of colloid chemistry and has discussed in nine chapters what might readily occupy as many large volumes. Graduate students should find inspiration here, but they should recognize that no scientific book can be considered as a final authority—particularly, not one on such rapidly advancing topics.

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Books Reviewed in The Scientific Monthly

November

The Development of the Concept of Electric Charge, D. Roller and D. H. D. Roller (Harvard Univ. Press). Reviewed by R. J. Stephenson.

Theories of Perception and the Concept of Structure, F. H. Allport (Wiley; Chapman & Hall). Reviewed by C. H. Bumstead.

On the Sensations of Tone as a Physiological Basis for the Theory of Music, H. L. F. Helmholtz (Dover). Reviewed by E. G. Wever.

Qataban and Sheba, W. Phillips (Harcourt, Brace). Reviewed by K. F. Mather.

Handbook of Algae, H. S. Forest (Univ. of Tennessee Press). Reviewed by G. W. Prescott.

Small-Fruit Culture, J. S. Shoemaker (McGraw-Hill). Reviewed by C. S. Waltman.

Time Counts, H. Watkins (Philosophical Library).

Nuclear Physics, I. Kaplan (Addison-Wesley). Reviewed by D. R. Corson.

The Prevalence of People, M. Bates (Scribner). Reviewed by P. W. Frank.

The Human Organism, R. M. DeCoursey (McGraw-Hill). Reviewed by A. D. Laton.

L'Acoustique des Orthoptères, Institut National de la Recherche Agronomique (Régisseur des Publications, I. N. R. A.). Reviewed by H. Frings.

The Human Brain, J. Pfeiffer (Harper). Reviewed by C. McC. Brooks.

Doctors in the Sky, Robert J. Benford (Thomas). Reviewed by D. W. Hastings.

The Tree of Culture, R. Linton (Knopf). Reviewed by J. Gillin.

Descriptive College Physics, H. E. White (Van Nostrand; Macmillan). Reviewed by M. W. Zemansky.

Electricity, E. deVille (Penguin). Reviewed by D. H. D. Roller.

New Books

Silicic Science. A review of the colloid scientific properties and phenomena exhibited by matter composed essentially of the element silicon. Ernst H. Hauser. Van Nostrand, New York, 1955. 188 pp. $5.

Progress in the Chemistry of Organic Natural Products. vol. XII. L. Zechmeister, Ed. Springer, Vienna, Austria, 1955. 550 pp. $19.80.

Comprehensive Inorganic Chemistry. vol. 4. pt. I, *Zinc, Cadmium, and Mercury,* Howard M. Cyr and editors; pt. II, *Scandium, Yttrium, and the Lanthanide Series,* Thomas D. O'Brien and editors. N. Cannon Sneed and Robert C. Brasted, Eds. Van Nostrand, New York, 1955. 193 pp. $5.

A History of the Classification of the Phylum Brachiopoda. Helen Marguerite Muir-Wood. British Museum (Natural History), London, 1955. 124 pp. £1.

The Expression of the Emotions in Man and Animals. Charles Darwin; with a preface by Margaret Mead. Philosophical Library, New York, 1955. 372 pp. $6.

Handbook for Teaching of Conservation and Resource-Use. Prepared by NABT National Conservation Committee; Richard L. Weaver, Project Leader. National Assoc. of Biology Teachers, Ann Arbor, Mich., in conjunction with American Nature Assoc., Washington, 1955 (Order from Project Leader, P.O. Box 2073, Ann Arbor, Mich.). 499 pp. $4.

Laboratory Studies in the Principles of Zoology. J. M. Carpenter, J. M. Edney, R. W. Barbour. Burgess, Minneapolis 15, 1955. 71 pp. $2.

American Foundations and Their Fields. Wilmer Shields Rich. American Foundations Information Service, New York, ed. 7, 1955. 744 pp. $35.

The World We Live In. Lincoln Barnett and editorial staff of *Life.* Time Inc., New York, 1955. 304 pp. $13.50, regular edition; $15, deluxe boxed edition.

Wild America. The record of a 30,000-mile journey around the continent by a distinguished naturalist and his British colleague. Roger Tory Peterson and James Fisher. Houghton Mifflin, Boston, 1955. 434 pp. $5.

Spider, Egg, and Microcosm. Eugene Kinkead. Knopf, New York, 1955. 243 pp. $4.

Birds and Men. American birds in science, art, literature, and conservation, 1800–1900. Robert Henry Welker. Belknap Press of Harvard Univ. Press, Cambridge, Mass., 1955. 230 pp. $5.75.

Official Methods of Analysis of the Association of Official Agricultural Chemists. William Horwitz, Ed. Assoc. of Official Agricultural Chemists, Washington, ed. 8, 1955. 1008 pp. $12.

Textbook of Occupational Therapy with Chief Reference to Psychological Medicine. Eamon N. M. O'Sullivan. Philosophical Library, New York, 1955. 319 pp. $10.

Static and Dynamic Electron Optics. An account of focusing in lens, deflector and accelerator. Cambridge Monogr. on Mechanics and Applied Mathematics. P. A. Sturrock. Cambridge Univ. Press, London, 1955. 240 pp. $5.50.

Reports on Progress in Physics. A. C. Stickland, Ed. Physical Soc., London, 1955. 477 pp. £2 10s.

Theoretical Genetics. Richard B. Goldschmidt. Univ. of California Press, Berkeley, 1955. 563 pp. $8.50.

A History of the United States Army Dental Service in World War II. George F. Jeffcott. Historical Unit, Army Medical Service, Washington, 1955 (Order from Supt. of Documents, GPO, Washington 25). 362 pp. $3.25.

General Chemistry Workbook. Conway Pierce and R. Nelson Smith. Freeman, San Francisco, 1955. 249 pp. $1.65.

College Algebra and Trigonometry. A basic integrated course. Frederic H. Miller. Wiley, New York; Chapman & Hall, London, ed. 2, 1955. 342 pp. $4.50.

Science, Religion & Reality. Joseph Needham, Ed.; introductory essay by George Sarton. Braziller, New York, 1955. 355 pp. $3.95.

Addendum 1955 to the British Pharmacopoeia 1953. General Medical Council. Pharmaceutical Press, London, 1955. 93 pp. 21s.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Tenth Annual Report of the President to the Trustees. Midwest Research Inst., Kansas City, Mo., 1955. 14 pp.

A Review of the Upper Eocene Artiodactyla of North America. Misc. Coll., vol. 128, No. 8. C. Lewis Gazin. 96 pp. *Leading Operations of the Smithsonian Astrophysical Observatory, 1895–1955.* Misc. Coll., vol. 131, No. 1. C. G. Abbott. 8 pp. Smithsonian Institution, Washington, 1955.

A Monograph of the Clingfishes (Order Xenopterygii). Stanford Ichthyological Bull., vol. 6. John C. Briggs. Natural History Museum of Stanford Univ., Stanford, Calif., 1955. 224 pp.

The Life in the Sea. Ralph Buchsbaum. Univ. of Oregon Press, Eugene, 1955. 101 pp. $1.50.

Atlas Anatomique des Biois du Congo Belge. vol. 1, *Spermatophytes.* Posocarpaceae, Cupressaceae, Ulmaceae, Moraceae, Proteaceae, Olacaceae. Lucien Lebacq. Institut National pour L'Etude Agronomique du Congo Belge, Bruxelles, 1955. 32 pp. + 32 plates.

Sixth Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year Ending 30th June, 1954. Government Printing Office, Canberra, Australia, 1954. 179 pp. 10s. 6d.

Biological Sciences Serial Publications, a World List, 1950–1954. Science Div., Library of Congress. Biological Abstracts, Univ. of Pennsylvania, Philadelphia 4, 1955. 269 pp. $2.

Heat Transfer—St. Louis. Chemical Engineering Progress Symposium Ser., vol. 51, No. 17. F. J. Van Antwerpen, Ed. American Inst. of Chemical Engineers, New York 36, 1955. 109 pp.

Head Sensations and the Concept of Inhibited Growth. Contribution to Modern Thought Ser., No. 1. Caron Kent. *Another "Jill."* Jane Kamm. *Aspects of Emotional Health.* Caron Kent. *Alcoholism, a Compulsion.* Caron Kent. *On Headaches and the Possibility of Inhibited Growth.* Caron Kent. Our Peace of Mind Ser., No. 6. 29 pp. Clinic for Psychotherapy, East Melbourne, Australia, 1955.

Congrès International de Biochimie, 3rd, Résumés des Communications. The Congress, Brussels, 1955 (Order from Secretariat General, 17 place Delcour, Liege, Belgique).

Institut Pasteur de Saigon, Rapport sur le Fonctionnement Technique en 1954. The Institute, Saigon, 1955. 125 pp.

University of the State of New York, Proceedings of the Eighty-Seventh Convocation. 8 and 9 April 1954, Albany. Bull. No. 1436. The University, Albany, 1955. 336 pp.

Rockefeller Foundation, President's Review from the Annual Report, 1954. The Foundation, New York, 1955. 145 pp.

Indian Agricultural Research Institute. The Institute, New Delhi, 1955. 79 pp.

A New Cambarus of the Diogenes Section from North Louisiana (Decapoda, Astacidae). Tulane Studies in Zoology, vol. 3, No. 4. George Henry Penn. Tulane Univ., New Orleans, La., 1955. 9 pp.

Scientific Meetings

International Congress of Anatomists

The Sixth International Congress of Anatomists was held at the New Faculty of Medicine, Paris, 25–30 July. Rémy Collin was the presiding officer, and Gaston Cordier and André Delmas comprised the committee of organization. The attendance numbered 899 individuals from 46 countries (France, 218; U.S., 144; Great Britain, 117; Italy, 84; Germany, 80; Netherlands, 40; Portugal, 26; Spain, 19; Switzerland, 17; Canada, 16; Belgium, 15; Yugoslavia, 14; Denmark, 12; India, 9; Egypt, 8; Brazil and Sweden, 7 each; Japan, 6; Austria and Turkey, 5 each; Finland, French Africa, and Poland, 4 each; Hungary, Iran, Mexico, and Uruguay, 3 each; Australia, Bulgaria, Chile, Czechoslovakia, Eire, Indonesia, and the U.S.S.R., 2 each; Argentina, Cuba, Greece, Israel, Lebanon, Malaya, New Zealand, North Ireland, Norway, Peru, Union of South Africa, and Viet Nam, 1 each).

Four hundred and eighteen papers and 125 demonstrations were presented. Owing to the large number of communications, it was necessary to run several concurrent sections during each session of the meeting. For convenience, the papers were grouped in nine categories. Although, as in any such classification, the grouping of many individual papers was necessarily arbitrary and controversial, the number of papers in the various caegories will serve as an indication of the meeting's scope: macroscopic anatomy, 93 papers; endocrinology, 58; biology, 57; general histology, 54; embryology, 49; neurology, 46; physical anthropology including nonprimate comparative anatomy, 41 (physical anthropology, 32; comparative anatomy, 9); special histology, 11; and cytohistology of the nervous system, 9.

A revised anatomical nomenclature for man was submitted to the congress by the International Anatomical Nomenclature Committee, which had been appointed by the fifth international anatomical congress, held at Oxford in 1950, to revise the *Basle Nomina Anatomica* of 1895. The latter, the first real effort to create a standard terminology for human anatomy, was largely the work of German anatomists. Although it was adopted in the U.S. and Italy, and eventually in Great Britain, it was practically ignored in France and other Latin countries. Subsequent revisions of the *B.N.A.* by German and British anatomists failed to gain universal acceptance. It was generally agreed, however, that a revised nomenclature that would be internationally acceptable was highly desirable. This led to the appointment of a committee by the Oxford congress and thus to the present list of terms. One feature of this newest revision is that it tends, at least in some degree, to abolish the terminological conflicts that have existed between comparative anatomy and human anatomy, chiefly because of the peculiar posture of man. Whether the altered human nomenclature submitted at Paris will gain universal acceptance, however, will depend on its reception by the anatomists of various countries, and especially on the reactions of the various national anatomical societies. Whatever its deficiencies, and some are inevitable, its acceptance is to be hoped for; for there is obviously need for an end to the present nomenclatural chaos.

Among the entertainments provided for the members of the congress, there may be especially mentioned a reception by the mayor of Paris at the Hotel de Ville, a conducted tour through the halls of ancient sculpture at the Louvre, and an unforgettable evening of dinner and entertainment at the palace of Versailles.

WILLIAM L. STRAUS, JR.
Johns Hopkins University
Baltimore, Maryland

Meeting Notes

■ The Animal Care Panel will meet 1–2 Dec. at the Henry Hudson Hotel in New York. The program will consist of papers dealing with the physiology and behavior of laboratory animals, their diseases, nutrition, and related problems. The Animal Care Panel is an organization of investigators, administrators of animal quarters, animal breeders, and food and cage manufacturers. For further information, write to L. R. Christensen, Director, New York University–Bellevue Medical Center, 550 First Ave., New York 16.

■ Columbia University's department of civil engineering and engineering mechanics and its Institute of Air Flight Structures will be joint sponsors with the Office of Scientific Research of the U.S. Air Force of an international conference on fatigue in aircraft structures to be held at Columbia 30 Jan.–1 Feb. Alfred M. Freudenthal, professor of civil engineering, is chairman of the organizing committee for the conference.

The meeting—which will include participants from Australia, Great Britain, Germany, and Sweden, as well as the United States—has been arranged to awaken the interest of research workers and aircraft designers in solving the design and structural problems that have arisen with the coming of the jet era in aviation. Also, it is hoped that a pooling of existing information on the subject will result.

Structural stresses caused by cabin pressure in high-speed flying, long a matter of concern to specialists, became known to the general public after the recent crashes of two British Comet jet airliners. It is suspected that structural failures were responsible for these disasters and that pressure-induced wing failures have been the cause of a number of other crashes of civilian and military aircraft.

■ A Conference on Technology for Israel and the Middle East will take place at the Hotel Statler in New York, 19–20 Nov. Under sponsorship of the American Technion Society, the meeting will be divided into sessions at which the speakers will review the economic problems of the area and offer advice for development of natural resources, housing, technical manpower, and power resources. Leading figures in science, engineering, and industry will deliver technical papers.

■ The International Union of Crystallography, in collaboration with Consejo Superior de Investigaciones Cientificas, will hold a symposium on Structure on a Scale between the Atomic and Microscopic Dimensions in Madrid, Spain, 2–7 Apr. 1956. The results obtained by both old and new techniques, including x-ray and electron diffraction and microscopy, will be discussed. Anyone who wishes to present a paper should send a title and a 10-line abstract to the program chairman *before 1 Jan. 1956*: Prof. A. Guinier, Conservatoire National des Arts et Metiers, 292 Rue St. Martin, Paris (3e), France.

Two IUC commissions (crystallographic apparatus and crystallographic teaching) will also hold meetings during this period. Further information may be obtained from the secretary of the local committee: Dr. M. Abbad, Serrano 118, Madrid, Spain.

Kodak reports to laboratories on:

sponsored films for the kiddies . . . a fluoborate prop for the p-nitrobenzenediazonium ion . . . what you could have learned about our photoconductive cell

A gift horse's teeth

On the one hand, the educators, facing the oncoming hordes of kids by the unanticipated millions. With so pitifully few skillful and enthusiastic teachers to serve as infantry, reliance on the audio-visual artillery and cavalry must inevitably grow. Moreover, much of it is free, from public-spirited sources interested in the education of the young. Too bad that these gorgeously colored 16mm gift horses have to be looked so closely in the mouth to make sure they leave some more lasting kernel of truth than that Zilch's Flashlights pierce more gloom.

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We're in the middle. We make projectors for the schools and film for Zilch's producer to use. We think both sides ought to be interested in the new booklet of the Association of National Advertisers, entitled "Criteria for Business-Sponsored Educational Films." ($2, from A. N. A.'s headquarters, 285 Madison Avenue, New York 17, N. Y.)

Phenols by chromatography

A customer reassured us that the fluoborate prop would hold *p-Nitrobenzenediazonium Fluoborate* (Eastman P7078) together, and it has. All that paper chromatographers want of it is the p-nitrobenzenediazonium ion to form characteristically colored azo dyes with methylolphenols ($C_6H_nOH(CH_2OH)_{5-n}$).

To get at other phenols, one makes such derivatives out of them. The clever chap who thought this up was only studying the phenol-formaldehyde resin formation reaction, and here, willy-nilly, it looks as though he has opened up paper chromatography for phenols.

Somebody is always opening up new fields for paper chromatography, a technique of which the main fault seems to be that it is so simple it doesn't help build up a lab's budget very fast. If this doesn't bother you and if you are not too proud at this late date to read through a brief, no-nonsense introduction to paper chromatography, we can send you the October issue of our *Organic Chemical Bulletin,* which is devoted to the subject. This will put you on the mailing list for that publication, in which our working chemists write review articles for the benefit of the archives and fellow tribesmen. If the absence of clever copywriting and fancy layout from that 28-year-old little periodical should prove in time to bore you, you can always arrange to have your free subscription cancelled.

To subscribe to the Bulletin, *order* p-Nitrobenzenediazonium Fluoborate, *or request a copy of our List No. 39 of some 3500 Eastman Organic Chemicals, get in touch with Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).*

PbS on a slip of glass

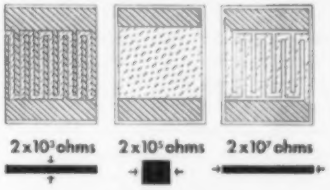
A little more than a year ago, in an advertisement that looked much like this one, there appeared an ecstatic announcement of a new type of photoconductive cell, y-clept *Kodak Ektron Detector.* No literature was offered—just the name of a man who could supply ordering information and transact business. If you had been one of those not repelled by such antediluvian merchandising technique, if, on the contrary, you had been sufficiently aroused to invest the price of an evening at a night club in a little .030″-thick rectangle of glass coated with lead sulfide, you might have found out for yourself some of the following facts about it:

Response extends from a few Å in the x-ray region through the whole ultraviolet and the visible, all the way to 3.5μ in the infrared. Probably the reason response stops there is the infrared transparency of lead sulfide. It can't very well respond to radiation it can't stop.

The sensitive area can be in the shape of a square a quarter millimeter on a side, a rectangle as big as a playing card, an etching of moonrise over Fujiyama, or a draftsman's nightmare inspired by Boolian algebra. It's just a coating on a plate —no envelope, nothing to shake loose. Moreover, signal response is strangely independent of sensitive area size. (Almost. At a given point in the range where response is linear with bias voltage, the signal is roughly proportional to the 0.1 power of area.)

Sensitivity of the surface is so uniform that, in general, an 0.25 mm^2 spot scanning a 250 mm^2 cell surface produces signals varying no more than 50% from the mean. Much better, of course, with a bigger spot.

Signal-to-noise ratio with infrared radiation is high. Cooling to dry ice temperatures boosts signal response much more than noise. Also, cutting current density cuts noise. Just by pattern changes, a cell of given size can have a 10,000:1 range of impedance, viz.:



Time constant may be anywhere from 400 to 1000 μsec. depending on the individual cell. At 60 C, frequency response is flat from 0 to 500 cycles; at 20 C, a drop is already noticeable at 120 cycles. When refrigerated for supersensitivity, drop in response with illumination chopping frequency is continuous. If the system can be operated at a sufficiently high frequency, response becomes virtually independent of temperature.

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The fourth general assembly and international congress of the IUC will be held at McGill University, Montreal, Canada, 10–17 July 1957, and will be followed by two symposia, 18–19 July. Additional information will appear in *Acta Crystallographica.*

■ Plans are being made for the first Pan American Cancer Cytology Congress, which is to be held in Miami, Fla., in Jan. 1957. The congress will be sponsored by the Southern Society of Cancer Cytology, the Cancer Institute at Miami, and the Cancer Cytology Foundation of America, Inc., New York, in collaboration with other interested societies.

The meeting will honor George N. Papanicolaou for pioneer research in the field of cancer control through early diagnosis. The organizing committee is as follows: honorary president, E. V. Cowdry; general chairman, J. Ernest Ayre; cochairman, M. J. Kopac, New York University; F. Bayard Carter, Duke University; Paul Klemperer, Columbia University; and John R. Heller, director, National Cancer Institute, Washington, D.C. Foreign representatives include Alberto Rivero, Caracas, Venezuela; Jose Maria Mezzadra, Buenos Aires, Argentina; and William Terzano, Buenos Aires, Argentina.

Ayre, as spokesman for the organizing committee, has indicated that through the good offices of Sen. Smathers of Florida arrangements are being made for invitations to go to Latin American countries through the U.S. State Department. Grants in support of the Congress have been secured from the Public Health Foundation for Cancer and Blood Pressure Research, Inc., of New York and the Cancer Cytology Foundation of America, Inc., of New York. The byword of the congress will be "Cancer protection through early detection."

■ The fourth national convention for teachers of science that is being planned by the National Science Teachers Association will be held 14–17 Mar. 1956 at the Shoreham Hotel in Washington, D.C. With sessions designed for elementary schools, junior and senior high schools, and colleges, it is expected that 1500 teachers will attend the convention. The convention theme is *Problem Solving—How We Learn.*

Features of the meeting will include the annual Exposition of Science Teaching Aids and "interview visits" to several of the research centers in and around Washington. Included in the latter will be the National Bureau of Standards and the National Institutes of Health.

The entire program is being planned to give practical helps for classroom teaching situations and problems. The first day's activities will center about the problem of "Learning how to find out." This will be followed by the laboratory visits and talks by scientists dealing with "Finding out what nobody knows." The third day of the convention will deal specifically with "Finding out what we have learned."

General planning of the convention is by a committee under the chairmanship of Henry A. Shannon, adviser in science and mathematics, State Department of Public Instruction, Raleigh, N.C. Robert Stollberg, professor of science and education, San Francisco State College, is president of the association, which now has more than 8000 members. He and the executive secretary of the Association, Robert H. Carleton, are serving with the planning committee.

Other committee members are Hubert N. Alyea, Princeton University; Glenn O. Blough, University of Maryland; Ruth Cornell, Wilmington, Del., Public Schools; Hubert M. Evans, Teachers College, Columbia University; Thelma Heatwole, chairman of the Virginia Academy of Science; Keith Johnson, Washington, D.C., Public Schools; and Richard W. Schulz, Emmerich Manual Training High School, Indianapolis, Ind.

Society Elections

■ Academy of Psychosomatic Medicine: pres., Alfred J. Cantor, Flushing, N.Y.; pres.-elect, Samuel M. Poindexter, Boise, Idaho; sec.-treas., Ethan Allan Brown, 75 Bay State Rd., Boston 15. The vice presidents are Harry Phillips, East St. Louis, Ill.; Carlos Seguin, Lima, Peru; and George F. Sutherland, Baltimore, Md.

■ Mycological Society of America: pres., Ralph Emerson, University of California, Berkeley; pres.-elect, Donald P. Rogers, New York Botanical Garden, New York; v. pres., John R. Raper, Harvard University; sec.-treas., Constantine J. Alexopoulos, Michigan State University. Emerson and William W. Diehl are the representatives to the AAAS Council.

Forthcoming Events

December

11–14. **American Soc. of Agricultural Engineers, Chicago, Ill. (F. B. Lanham, ASAE, St. Joseph, Mich.)**

11–14. **American Soc. of Refrigerating Engineers, New York, N.Y. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)**

14. **Operations Research Symposium, Philadelphia, Pa. (R. V. D. Campbell, Operations Research Symposium Registration, Burroughs Research Center, Paoli, Pa.)**

15–17. **Acoustical Soc. of America, Providence, R.I. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)**

15–17. **International Union of Scientific Radio, U.S. national, Gainesville, Fla. (J. P. Hagen, Code 7100, URSI, Naval Research Lab., Washington 25.)**

16–21. **Interamerican Cong. of Psychology, 3rd, Austin, Tex. (W. Holtzman, Univ. of Texas, Austin.)**

26–29. **Biometric Soc., Eastern N. American Region, New York, N.Y. (A. M. Dutton, Box 287, Station 3, Rochester 20, N.Y.)**

26–31. American Assoc. for the Advancement of Science, Atlanta, Ga. (R. L. Taylor, AAAS, 1025 Connecticut Ave., NW, Washington 6.)

The following 32 meetings will be held in conjunction with the AAAS annual meeting.

26–27. American Assoc. of Clinical Chemists, Atlanta, Ga. (A. E. Sobel, Dept. of Biochemistry, Jewish Hospital of Brooklyn, 555 Prospect Pl., Brooklyn 16, N.Y.)

26–30. American Nature Study Soc., Atlanta, Ga. (M. Trussell, School of Education, Florida State Univ., Tallahassee.)

26–30. National Assoc. of Biology Teachers, Atlanta, Ga. (J. P. Harrold, 110 E. Hines St., Midland, Mich.)

27. National Assoc. of Science Writers, Atlanta, Ga. (O. Fanning, Midwest Research Inst., Kansas City, Mo.)

27. National Speleological Soc., Atlanta, Ga. (Bro. G. Nicholas, F.S.C., 114 Hanover St., Cumberland, Md.)

27. Soc. for Research in Child Development, Atlanta, Ga. (W. C. Rhodes, Georgia Dept. of Public Health, Atlanta.)

27–28. American Psychiatric Assoc., Atlanta, Ga. (H. E. Himwich, Research Div., Galesburg State Research Hospital, Galesburg, Ill.)

27–28. Soc. for the Advancement of General Systems Theory, Atlanta, Ga. (L. von Bertalanffy, Psychosomatic Research Inst., Mt. Sinai Hospital, Los Angeles, Calif.)

27–29. American Geophysical Union, Atlanta, Ga. (W. Smith, 1530 P St., NW, Washington 5.)

27–29. American Meteorological Soc., Atlanta, Ga. (K. Spengler, 3 Joy St., Boston, Mass.)

27–29. Assoc. of Southeastern Biologists, Atlanta, Ga. (M. E. Gaulden, Biology Div., Oak Ridge National Lab., Oak Ridge, Tenn.)

27–29. International Geophysical Year, Atlanta, Ga. (H. Odishaw, National Research Council, Washington 25.)

27–29. Oak Ridge Inst. of Nuclear Studies, Atlanta, Ga. (C. L. Comar, ORINS, Oak Ridge, Tenn.)

27, 29. Soc. of the Sigma Xi, Atlanta, Ga. (T. T. Holme, 56 Hillhouse Ave., New Haven, Conn.)

27–30. American Phytopathological Soc., Atlanta, Ga. (G. S. Pound, Dept. of Plant Pathology, Univ. of Wisconsin, Madison.)

27–30. American Soc. of Parasitologists, Atlanta, Ga. (A. C. Walton, Dept. of Biology, Knox College, Galesburg, Ill.)

27–30. Botanical Soc. of America,

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Southeastern Section, Atlanta, Ga. (R. E. Shanks, Univ. of Tennessee, Knoxville.)

27–30. Ecological Soc. of America, Atlanta, Ga. (E. P. Odum, Univ. of Georgia, Athens.)

27–30. National Science Teachers Assoc., Atlanta, Ga. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

27–30. Soc. of Systematic Zoology, Atlanta, Ga. (D. C. Scott, Dept. of Zoology, Univ. of Georgia, Athens.)

28. Alpha Epsilon Delta, Atlanta, Ga. (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.)

28. National Assoc. for Research in Science Teaching, Atlanta, Ga. (G. G. Mallinson, Western Michigan College of Education, Kalamazoo.)

28. Sigma Pi Sigma, Atlanta, Ga. (D. R. McMillan, Emory Univ., Emory University, Ga.)

28. Soc. of General Physiologists, Atlanta, Ga. (A. Shanes, National Institutes of Health, Bethesda 14, Md.)

28–29. American Soc. of Naturalists, Atlanta, Ga. (W. P. Spencer, Dept. of Genetics, Univ. of Texas, Austin 12.)

28–29. Conference on Scientific Editorial Problems, Atlanta, Ga. (R. W. Russell, 3518 University Ave., Los Angeles 7, Calif.)

28–29. Herpetologists League, Atlanta, Ga. (J. A. Fowler, Acad. of Natural Sciences, 19th and Parkway, Philadelphia 3, Pa.)

29. American Assoc. of Hospital Consultants, Atlanta, Ga. (J. Masur, Asst. Surgeon-General, USPHS, Washington 25.)

29. National Acad. of Economics and Political Science, Atlanta, Ga. (D. P. Ray, Hall of Government, George Washington Univ., Washington, D.C.)

29. National Geographic Soc., Atlanta, Ga. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6.)

29. Scientific Research Soc. of America, Atlanta, Ga. (D. B. Prentice, 54 Hillhouse Ave., New Haven, Conn.)

30. American Soc. of Plant Physiologists, Southern Section, Atlanta, Ga. (A. W. Naylor, Duke Univ., Durham, N.C.)

30. United Chapters of Phi Beta Kappa, Atlanta, Ga. (C. Billman, 1811 Q St., NW, Washington, D.C.)

27–29. American Mathematical Soc., 62nd annual, Houston, Tex. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)

27–29. Archaeological Inst. of America, Chicago, Ill. (C. Boulter, 608, Univ. of Cincinnati Library, Cincinnati 21, Ohio.)

27–29. Assoc. for Symbolic Logic, Rochester, N.Y. (J. Barlaz, Rutgers Univ., New Brunswick, N.J.)

27–29. Linguistic Soc. of America, Chicago, Ill. (A. A. Hill, 1719 Massachusetts Ave., NW, Washington 6.)

27–29. Western Soc. of Naturalists, Davis, Calif. (D. Davenport, Univ. of California, Santa Barbara.)

27–30. American Statistical Assoc., New York, N.Y. (E. M. Bisgyer, 1757 K St., NW, Washington 6.)

27–30. Inst. of Mathematical Statistics, New York, N.Y. (K. J. Arnold, Dept. of Mathematics, Michigan State Univ., East Lansing.)

27–1. Phi Delta Kappa, 50th anniversary, Bloomington, Ind. (J. C. Whinnery, 324 N. Greenwood Ave., Montebello, Calif.)

28–29. Northwest Scientific Assoc., Spokane, Wash. (F. J. Schadegg, Eastern Washington College of Education, Cheney.)

28–30. American Economic Assoc., New York, N.Y. (J. W. Bell, Northwestern Univ., Evanston, Ill.)

28–30. American Historical Assoc., Washington, D.C. (B. C. Shafer, Study Room 274, Library of Congress Annex, Washington 25.)

28–30. American Philological Assoc., Chicago, Ill. (J. P. MacKendrick, Bascom Hall, University of Wisconsin, Madison 6.)

28–30. Low Temperature Physics and Chemistry, Baton Rouge, La. (J. G. Daunt, Dept. of Physics, Ohio State Univ., Columbus 10.)

28–30. American Philosophical Assoc., Eastern Div., Boston, Mass. (W. H. Hay, Dept. of Philosophy, Univ. of Wisconsin, Madison.)

(See 21 Oct. issue for comprehensive list)

SCIENCE—1955

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Equipment News

■ KROMO-TOG, an instrument for the analysis of gases and liquids by gas chromatography, has been announced by Burrell. The instrument provides the basic instrumentation needed for analysis by the elution method. The volume of a gas sample required is ordinarily not more than 10 ml; the volume of a liquid sample required is usually less than 0.1 ml. Liquid samples must have 10 to 20 mm vapor pressure at the temperature of the analysis. The instrument includes a constant-temperature air bath, seven volume tubes, and helical heating coils. One- and two-column models are available. Booklet 83. (Burrell Corp., Dept. Sci., 2223 Fifth Ave., Pittsburgh 19, Pa.)

■ R-C OSCILLATOR type 1210-B provides, in addition to two sine-wave outputs, a square-wave output over a frequency range from 20 cy/sec to 500 kcy/sec. Square-wave output is 30 v peak-to-peak, rise time is about 0.25 μsec, and output impedance is 2500 ohms. Automatic recording of frequency characteristics on either a pen recorder or a cathode-ray oscillograph is made possible by a gear-driven precision dial that is arranged so that it may be driven automatically by a type 908-P synchronous dial drive. The motor can sweep any portion of each of the five decade frequency ranges. Frequency calibration accuracy is ± 3 percent. The logarithmic output control is calibrated from 0 to − 50 db. (General Radio Co., Dept. Sci., 275 Massachusetts Ave., Cambridge 39, Mass.)

■ FLAME PHOTOMETER by Norelco is designed for rapid sodium, potassium, and lithium analysis in industrial and medical laboratories. Selector switch on the front panel prepares the instrument for either potassium or sodium analysis. The instrument employs separate barrier-layer photo cells and individual filters. Separate sensitivity and zero controls are provided for each element. Readings are made on a 4-inch dial. (North American Philips Co., Inc., Research and Control Instruments Div., Dept. Sci., 750 S. Fulton Ave., Mount Vernon, N.Y.)

■ AUTOMATIC FRACTION COLLECTOR model 230 that is suitable for both time- and drop-counting operation has been released by Packard. The instrument consists of a mechanical unit, a turntable 24 in. in diameter, and a phototube unit and control cabinet. The timing system provides collecting intervals for each test tube from 15 sec to 100 min in 15-sec steps. Drop counter permits collection of 1 to 400 drops in each test tube. (Packard Instrument Co., Dept. Sci., P.O. Box 428, La Grange, Ill.)

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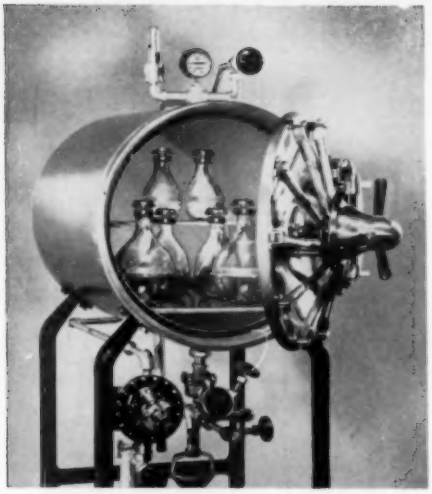

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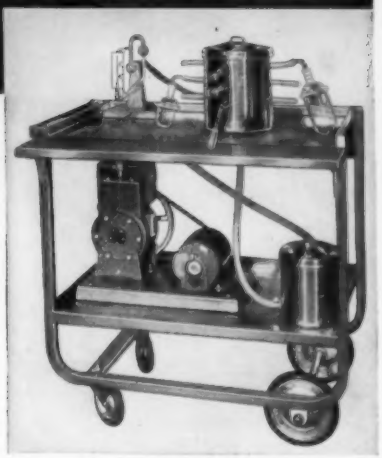

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